Cognitive processes underlying intrusion development

Intrusive images in analogue trauma

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Cognitive processes underlying intrusion development

Intrusive images in analogue trauma

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“In the Land of Memory, the time is always *Now*.
In the Kingdom of Ago, the clocks tick… but their hands never move.
There is an Unfound Door
(O lost)
And memory is the key which opens it.”

– Stephen King in *The Dark Tower VI: Song of Susannah* –

“I don't see much sense in that,” said Rabbit. “No,” said Pooh humbly, “there isn't. But there was going to be when I began it. It's just that something happened to it along the way”.

– Rabbit and Pooh in *Winnie the Pooh* –

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Chapter 1

Brief introduction and outline

Background

Intrusive memories are unwanted and uncontrollable images that pop into consciousness automatically, often after encounter with a perceptually matching stimulus. Often, these intrusions take the form of predominantly visual images (Speckens, Ehlers, Hackmann, Ruths, & Clark, 2007). For example, gruesome images of war on the news may linger in the mind and intrude into consciousness even when they're not welcome (Holmes, Creswell, & O'Connor, 2007). Apart from everyday life, intrusive images are prominent in many psychological disorders, such as bipolar disorder, depression, social phobia, and OCD (Hackmann & Holmes, 2004). In post-traumatic stress disorder (PTSD), experiencing intrusions is a key feature of the official diagnosis according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 2000). Perhaps it is for this reason that information processing models of PTSD (Brewin, Dalgleish, & Joseph, 1996; Ehlers & Clark, 2000) provide an elaborate and testable account of intrusion development in the context of psychological trauma. Several implications of these models have been translated into protocols for clinical practice (Ehlers, Clark, Hackmann, McManus, & Fennell, 2005), in which the reduction of intrusions is often an important theme. It is therefore highly surprising that these information processing models have not been extensively tested experimentally. The main goal of this dissertation was to contribute to the empirical grounding of the information processing models of PTSD on the issue of intrusion development. PTSD provides the clinical context in which intrusions are studied in this dissertation, and a brief background on the history and prevalence is provided below. The information processing models that provide the theoretical context of this dissertation are then briefly addressed. Finally, a brief outline of the chapters is provided. In Chapter 2, a full theoretical introduction and empirical review is provided for further reference.

Posttraumatic Stress Disorder: Clinical context

Post-traumatic stress disorder (PTSD) is categorized as an anxiety disorder in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 2000). In PTSD, a person has encountered a situation in which 'the person experienced, witnessed, or was confronted with an event or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of self and other' and 'the person's response involved intense fear, helplessness, or horror' (APA, 2000). Further diagnostic criteria consist of re-experiencing the traumatic event (e.g., intrusive images), avoidance behaviour (e.g., not wanting to think about the traumatic event), emotional numbing (e.g., a lack of interest in significant activities), and hyperarousal (e.g., sleeping problems). The diagnosis of PTSD is considered when the symptoms persist for more than one month after the traumatic event occurred.

Although people have always suffered from traumatic events, the diagnosis of PTSD was only included in the third edition of the Diagnostic and Statistical Manual of Mental Disorders in 1980 (DSM-III; APA, 1980). The inclusion of PTSD came with several political strings attached. It was the first disorder to be included as a psychiatric phenomenon that could be ascribed to circumstances outside the person. This was taken as recognition of psychological problems experienced by Vietnam veterans and survivors of concentration camps in WW II (Gersons & Carlier, 1992). Before, post-traumatic stress symptoms were mainly ascribed to an intrapsychic or neurotic problem because of a weak character. The recognition of a traumatic event as the cause of a patient's symptoms paved the way for an understanding of suffering caused by war, as well as the right to compensation claims.

Before the term post-traumatic stress disorder came into place, stress symptoms caused by war did not go unnoticed, however. They were known under various names, like 'irritable heart syndrome', 'combat neuroses', 'war neurosis' and 'shell-shock' (Gersons & Carlier, 1992). The oldest account of what we now refer to as post-traumatic stress has been found in the biblical story of Jacob and Joseph in the book Genesis, with father Jacob showing signs of post-traumatic symptoms after the disappearance and apparent death of his son Joseph (Birnbaum, 2007).

Today, the lifetime prevalence of exposure to any traumatic event is estimated to be 89.6% in an American sample (Breslau, Kessler, Chilcoat, Schultz, Davis, & Andreski, 1996), to 64.6% (for men) and 49.5% (for women) in an Australian sample (Creamer, Burgess, & McFarlane, 2001), and 28% in Switzerland (Hepp et al., 2006). However, not everyone develops full-blown PTSD after a traumatic event. In the American sample mentioned above, the conditional risk for PTSD was 9.2%-13.0% for women and 6.2% for men (Breslau et al., 1996), whereas the 12-month prevalence of PTSD reported in the Australian sample was 1.33% (Creamer et al., 2001), and 1.30% in the Swiss sample (Hepp et al., 2006). So, although it is likely that people encounter a traumatic event at one point in their life, the probability that they will develop PTSD seems to depend on other factors.

Meta-analyses of studies about the onset and maintenance of PTSD have shown that peri-traumatic factors (e.g., emotional responses, perceived life threat, dissociation) are among the best predictors. It is therefore not surprising that cognitive theories of PTSD have focused on peri-traumatic processes in order to explain PTSD and one of its major features: intrusive re-experiencing. Theoretically it is proposed that the encoding of traumatic information in memory lies at the heart of re-experiencing symptoms. The goal of the studies that comprise this dissertation was to experimentally test the suggested role of information processing in the development of re-experiencing symptoms, intrusive images specifically. Below, information processing models of PTSD are briefly described. For a more detailed account, the reader is referred to Chapter 2 and Chapter 10.

Information processing models of PTSD: Theoretical context

The dual representation theory

The dual representation theory of PTSD (Brewin, Dalgleish, & Joseph, 1996; Brewin, 2001) states that trauma information is stored in two separate memory systems. The Verbally Accessible Memory (VAM) consists of memory representations that can be deliberately retrieved and overlaps with the more common concept of autobiographical memory (e.g., Conway, 1996). The VAMs consist of trauma information that is embedded within a meaningful context that integrates the information within autobiographical memory. Information that is consciously attended to at the time of the trauma is stored in the VAM system. The information stored in the Situationally Accessible Memory (SAM) was processed automatically in a raw fashion. Thus, SAMs mainly consists of perceptual information, but also of uncorrected cognitions about the traumatic event at the time (e.g., “I am going to die”). SAMs are automatically activated on encounter with a matching stimulus and are experienced as an intrusive memory. Accordingly, the information from the SAM system needs to be consciously processed and integrated within the VAM system or newly formed SAMs (e.g., “I did not die) need to be created that inhibit the automatic retrieval of the original SAM (Brewin, 2001) in order to reduce intrusive images.

The cognitive model of PTSD

The cognitive model of PTSD (Ehlers & Clark, 2000) states that a shift in balance towards more data-driven processing (i.e., processing of mostly perceptual information), in contrast to conceptual processing (i.e., more meaningful evaluations of the trauma) during the traumatic event results in intrusive images. The model does not suggest separate memory systems, but rather an episodic memory of the trauma consisting of mostly perceptual information (e.g., Conway, 1995). Episodic memory contains highly detailed information of specific events (e.g., watering the flowers in the garden this morning) and is part of autobiographical memory (Conway, 2005). The trauma information is automatically activated by matching stimuli, resulting in the experience of an intrusive memory. The trauma information is not easily integrated within the knowledge structures of autobiographical memory because of the large discrepancies between the implications of the trauma (e.g., "the world is not safe") and existing beliefs (e.g., "the world is predictable"). Furthermore, negative evaluations of the traumatic event and its consequences can lead to a feeling of "current threat", which, in turn, is thought to maintain PTSD symptoms (Ehlers & Clark, 2000).

Outline of the dissertation

Although the dual representation theory (Brewin et al., 1996) and the cognitive model of PTSD (Ehlers & Clark, 2000) differ on several aspects, they also converge on important theoretical points. Both models suggest that peri-traumatic processing that leads to image-based trauma representations in memory are the source of intrusive images. Further, the models agree that more integration of the trauma information within autobiographical memory should reduce intrusions. Importantly, reducing peri-traumatic perceptual processing or enhancing conceptual processing should then reduce intrusion frequency, as suggested by Holmes & Bourne (2008). An elaborate discussion of these theoretical accounts along with a review of associated empirical findings is provided in the theoretical Chapter 2.

As noted earlier, the information processing models of PTSD have not been subjected to extensive empirical investigations even though they are highly influential theoretically as well as clinically. In order to test their hypotheses about intrusion development, the studies reported in this dissertation made use of the 'trauma film paradigm' (Holmes & Bourne,

2008) to provide an analogy of a traumatic experience. Participants are typically shown a film of a traumatic situation which allows for experimental manipulation of peri-traumatic processes, which is not possible in already traumatized survivors. As noted, information processing models suggest that perceptual processing and conceptual processing during encoding of traumatic information are highly important in intrusion development. In Chapter 3, the role of peri-traumatic perceptual (i.e., visuospatial) processing in intrusion development is experimentally tested using the trauma film paradigm. In Chapter 4, a similar design was used to test the role of peri-traumatic conceptual (i.e., verbal) processing in intrusion development. According to the information processing models of PTSD (Brewin et al., 1996; Ehlers & Clark, 2000), an important stage in recovery from trauma is the integration of the trauma information in autobiographical memory. Chapter 5 aimed to test the hypothesis that enhancing the organization of traumatic information immediately post-trauma reduces intrusion development. The studies in Chapters 3 to 5 provide partial support for the information processing models of PTSD, but highly important inconsistencies that require revision of the models are also brought to light.

Chapters 3 to 5 aimed to experimentally test specific hypotheses about intrusion development derived from the information processing models of PTSD. Chapter 6 and 7 extended the scope of these models by exploring the development of intrusive visual images in the absence of direct visual input. As the models discussed above all assume direct visual input, Chapters 6 and 7 provide food for thought on the core nature of intrusions. Chapter 6 focuses on the role of peri-traumatic processing in the development of visual intrusive images from auditory traumatic information. Chapter 7 aimed to further elucidate working mechanisms underlying the development of intrusive visual images in the absence of direct visual input. Chapter 7 accordingly explored the role of mental imagery in the development of intrusive images from a film (i.e., direct visual input) versus a verbal report (i.e., a verbal description of the event). The combined results of these studies require a major reconceptualisation of the development of intrusive images as described by the information processing models.

Apart from peri-traumatic encoding processes, thought suppression and attentional bias have also been suggested to play a role in trauma. In Chapter 8, it is explored to what extent intrusive images can be deliberately controlled in comparison to non-intrusive images.

Given the straightforward nature of this research question, it is surprising that the large majority of previous studies on intrusions and thought suppression have confused several definitions of 'intrusion'. This crucial distinction is addressed in Chapter 8. Chapter 9 explores the role of attentional bias in the automatic activation of analogue trauma representations in memory. The results are highly interesting and shed light on the automatic effect of trauma reminders in ongoing processing thereby extending information processing models of PTSD. In Chapter 10, a theoretical review is provided reflecting on possible functions of intrusive re-experiencing. To conclude, Chapter 11 provides an overview of the major findings reported in this dissertation and proposes a new psychological model of intrusion development that encompasses these results.

Chapter 2

Exploring Involuntary Recall in Post-Traumatic Stress Disorder from an Information Processing Perspective: Intrusive Images of Trauma

This chapter is based on Krans, J., Woud, M. L., Näring, G., Becker, E. S., & Holmes, E. A. (in press). Exploring involuntary recall in post-traumatic stress disorder from an information processing perspective: Intrusive images of trauma. J. H. Mace (Ed.), *The act of remembering: Towards an understanding of how we recall the past.* Blackwell Publishing.

Introduction

The ability to recall our past is a very valuable and characteristically human quality. Remembering earlier experiences gives us a sense of who we are, where we are coming from and where we are going (Barclay, 1996). It provides us with a personal identity and sense of self, and it is through memory that we learn and that we develop ourselves. In memory's most romantic form, we take a trip down memory lane and think back to that summer's night with our love and we fully enjoy the remembrance. Unfortunately, a trip down memory lane can also confront us with negative experiences. For instance, our love might have rejected and left us. Usually, although painful, we can endure these negative memories. Sometimes, however, we have experiences so horrific or frightening that we would rather avoid remembering them at all. Ironically, memories of extremely negative or traumatic events seem to be far less under our control than the more pleasant or neutral ones and are appropriately termed "intrusive memories".

> *I was in my car that was parked in my street when a man puts a knife to my neck. He comes out of nowhere. I think I'm going to die and am afraid that he might hurt my daughter if he realises I live there. I try to be calm. The mugger says "give me all your money" and he is aggressive. I think I'm going to die. He checks my pockets and rummages through my purse. I should be aggressive and scare him, or start the car..., but I don't. He runs off and I look back to my house and see my daughter crying and banging at the door. Maybe she saw me and she could be traumatised. She's too young.*

The example above is a reconstruction of a trauma memory that came to be intrusive for the victim. We reconstructed the story based on actual reports from this victim collected by Holmes, Grey, and Young (2005, p. 9). The image of the mugger's knife on the neck and the daughter crying and banging at the door frequently haunt the victim, leading to high distress during this involuntary recall. In a follow-up study by Grey and Holmes (2008) more illustrations of intrusive images can be found. For example, one participant developed post-traumatic stress disorder (PTSD) after a road traffic accident and reported intrusive memories of the moment when a scaffold on the pavement smashed the windscreen of the car. At that time, the participant thought that they would be decapitated and the intrusive image of the scaffold is accompanied by intense anxiety (Grey & Holmes, 2008).

PTSD is classified as an anxiety disorder in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR, American Psychiatric Association, 2000). This psychological disorder can develop after a traumatic event, which is defined in the DSM-IV-TR as a situation in which 'the person experienced, witnessed, or was confronted with an event or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of self and other' and 'the person's response involved intense fear, helplessness, or horror.' Examples of traumatic events are experiencing or being a witness of military combat, violent personal assault and natural or man-made disasters (APA, 2000). The features that define PTSD are: *re-experiencing* the traumatic event in the form of intrusive images, thoughts or nightmares; *avoidance* of reminders of the traumatic event such as conversations about the trauma or the scene where the trauma occurred; *emotional numbing*, featured by a lack of interest for significant activities and feeling alienated from others; and symptoms of *hyperarousal* such as sleeping problems, irritability and exaggerated startle (APA, 2000). Post-traumatic stress symptoms are common after a traumatic event. Therefore, only in the case that the symptoms persist for more than one month the diagnosis of PTSD is considered.

There are several striking memory phenomena present in PTSD. For example, although a traumatic memory is usually very detailed, PTSD patients may have trouble with the deliberate recall of their experience, so-called trauma-related amnesia. Furthermore, traumatic memories can be activated by triggers that seem to have 'generalized' from the initial encoded information (Conway & Holmes, 2005). What is especially striking about re-experiencing in PTSD is the disruption of ongoing activities and attentional problems, often impairing important life aspects. The present chapter focuses on re-experiencing in the form of intrusive images. Intrusive images can be described as uncontrollable and unbidden mental pictures that pop into consciousness. An intrusive image is often a memory representation[1] of

[1] This is in contrast to intrusive images where the content depicts a worry or fear about something that could (have) happen(ed) but has not necessarily happened (e.g. the image of people laughing when preparing for a presentation in social phobia). However, research indicates that many intrusive images, at least in psychological disorders, are related to some earlier experience (Brewin, 1998).

the traumatic event, rich in sensory detail, as was illustrated by the mugging example earlier in this chapter. Because intrusive images develop in almost all PTSD patients (Speckens, Ehlers, Hackmann, Ruths, & Clark, 2007), it is a highly salient and important topic in clinical practice. A major goal of therapy is often to reduce the frequency of involuntary recall as well as the impact that the symptoms of re-experiencing have on the patient. Symptoms of re-experiencing are intriguing because they are somehow different from our "normal" memories, the ones that we can access and control more or less at will. The unbiddenness and uncontrollability that characterizes intrusive images indicates that during the processing of traumatic information something 'unusual' happens. As a result, intrusive images can lead to the subjective experience that the event is happening right now, rather than that the experience is something from the past. PTSD sufferers can relive the traumatic event and experience the negative emotions that were present during the original experience in a full-blown flashback. Markedly, there is a sense of "current threat" in PTSD (Ehlers & Clark, 2000), even though the traumatic event, and so the objective danger, is in the past. This could be said to be the differentiating feature of PTSD in relation to other anxiety disorders, where intrusions are usually related to a present or future threat. The here-and-now feature of traumatic intrusive memories indicates that during the processing of traumatic information, a temporal structure is relatively lacking, leading to a memory representation that lacks a conceptual context and is not integrated in autobiographical memory (Ehlers & Clark, 2000; Brewin, Dalgleish, & Joseph, 1996).

In sum, intrusive images are an intriguing topic of research because of their clinical importance and the theoretical enigmas that they confront us with. What follows is a discussion and review of the theory and the current state of research on intrusive images in PTSD from an information processing perspective.

PTSD Theories

Currently, information processing theories of PTSD are very influential in inspiring research on involuntary recall in trauma. However, other theoretical explanations have been put forward in the past. For example, in a pioneering series of laboratory studies, Horowitz (1969) applied a combination of psychoanalytic and psychobiological theory based on ideas by Freud and Breuer to explain the occurrence of intrusive images from stressful film material in healthy participants. Horowitz suggested that normally, the individual is in an emotional homeostasis where psychological processes are functioning in an integrated fashion. However, the overwhelming experience of a traumatic event can interfere with the psychological processes and disrupt homeostasis. As a consequence, a “repetition compulsion” occurs, in which the individual attempts to repress the traumatic memory but is unsuccessful because of weakened psychological defences, which results in intrusive images. At other times, the trauma memory is successfully repressed to protect the individual from being overwhelmed with emotions, resulting in amnesia. Successful repression and compulsive repetition in the form of intrusive memories are alternated in order to resolve the conflict induced by the traumatic event and to reinstate homeostasis. In a later paper, Horowitz (1975) introduced the concept of “cognitive processing”, a term relevant to current information processing theories of PTSD. Although the theory may seem outdated to us, Horowitz’ experimental paradigm is still highly relevant, as we shall see later on in this chapter. Brewin and Holmes (2003) noted that Horowitz was a pioneer in modern day experimental research of trauma. In their review (Brewin & Holmes, 2003), the authors evaluated the most influential theories of PTSD from past to present. They conclude that current information processing models of PTSD have the advantage that they allow for the generation of specific hypotheses as well as providing a theoretical explanation for the entire spectrum of PTSD symptoms.

Current information processing models of PTSD are largely based on theories of autobiographical memory that describe “normal” memory processes. For example, Conway and Pleydell-Pearce (2000) propose a model of autobiographical memory in which information is stored in different levels of specificity. Very detailed memory representations that mainly consist of perceptual information are part of the Event Specific Knowledge (ESK) that forms episodic memories. Information in the ESK is usually abstracted into General Events that can include one or more events with a common theme. At the top of this hierarchy are Lifetime Periods that describe more general knowledge about a certain life-time period. Specific patterns of activation across these levels define an autobiographical memory. Goals of the self direct the formation of knowledge structures and hence regulate the organisation and retrieval of autobiographical memories. Theories of PTSD aim to specify what processes in memory formation depart from “normal” processing in order to explain PTSD symptoms.

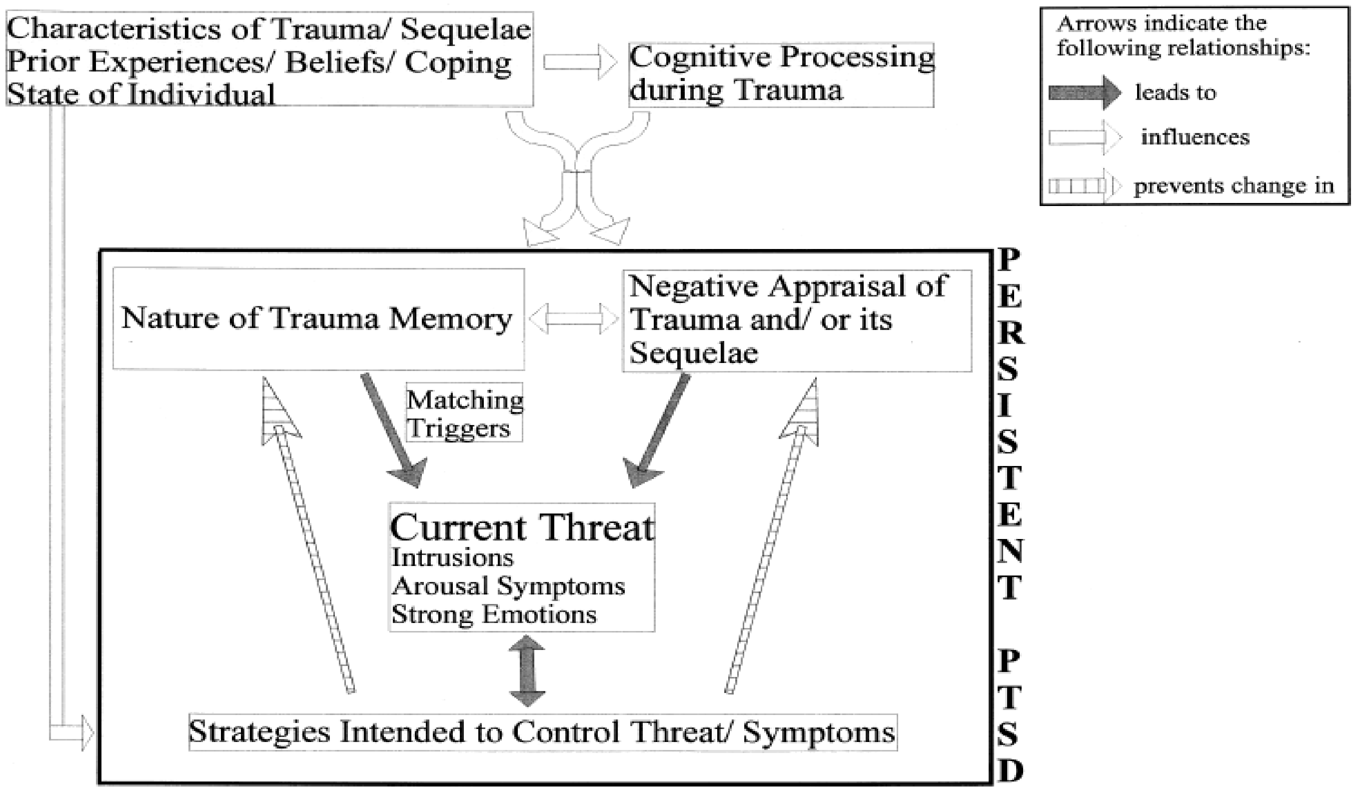

Figure 1. Model reprinted from Ehlers and Clark (2000).

The cognitive model of PTSD

One information processing theory that is very influential in experimental research on intrusive images is the cognitive model of PTSD (Ehlers & Clark, 2000). The model acknowledges that post-traumatic stress symptoms are a normal phenomenon in the direct aftermath of a traumatic event. A main difference between 'normal' and pathological reactions, according to this model, is the experience of 'current threat' in PTSD, which, as mentioned earlier, also delineates an important difference between PTSD and other anxiety disorders. According to the cognitive model of PTSD, current threat is caused by extremely negative appraisals of the traumatic event and its consequences and by characteristics of the trauma memory itself. Although the main focus of the model is on the persisting power of the negative appraisals, the quality of the trauma memory plays a crucial part as well. The cognitive model of PTSD suggests that conceptual processing leads to 'normal' autobiographical memory representations that can be retrieved deliberately. In contrast, more data-driven processing (e.g., being absorbed by sensory information) leads to memory representations that relatively lack a conceptual context and are therefore easily activated by internal or external cues. Data-driven processing leads to an enhanced perceptual priming effect for traumatic material. This entails that traumatic information in memory is especially sensitive for perceptually similar stimuli that automatically trigger the trauma memory representation. Ehlers and Clark (2000) offer extensive suggestions of treatment interventions based on their model. One of their suggestions is to reduce current threat by learning to discriminate between the past (the time of the traumatic event) and the present by looking at differences between objectively neutral stimuli that signalled danger then but not now. This way, the traumatic event is thought to become more integrated in autobiographical memory and unhelpful appraisals that maintain symptomatology are corrected.

The dual representation theory

Another influential information processing model of PTSD is the dual representation theory (DRT; Brewin, 1989; Brewin, Dalgleish, & Joseph, 1996; Brewin, 2001). DRT states that information from a traumatic event is represented in two separate memory systems. This idea is based on the distinction between conscious processing, which is a slow and serial process wherein reflective meaning is conveyed to the information that is encoded, and a more automatic processing of raw (often sensory) information. The latter process operates in a parallel fashion, thereby having more or less unlimited processing capacity. Memory representations that stem from this automatic processing contain mostly sensory information from the event, but also the meaning that was assigned at the time (e.g., this is a life-threatening situation). Memory representations stemming from more conscious processing can also involve perceptual features but are foremostly integrated in a conceptual context bound by the temporal and causal structure of the event. These representations can be retrieved deliberately from autobiographical memory, and are apt to change due to conscious reprocessing. These memory representations are called Verbally Accessible Memories (VAMs). DRT states that during a traumatic event, the conscious processing of information is interfered through hormonal changes that are associated with extreme stress reactions. In contrast, the more automatic processing is not much affected by extreme stress, and may even be enhanced. The memory representations that stem from automatic processing have not been subjected to conscious elaboration and assignment of meaning, so they cannot be retrieved deliberately. However, because they contain detailed sensory information, these memory representations are automatically activated by stimuli that bare similar sensory qualities (visual, olfactory, bodily sensations, emotions, etcetera) with the information that is encoded. Therefore, in the DRT (Brewin, 1989; Brewin et al., 1996; Brewin, 2001), the latter memory representations have been termed Situationally Accessible Memories (SAMs). In effect, the SAMs constitute the involuntarily recalled experiences - or intrusive images - after a traumatic event. Depending on several factors (e.g., duration and severity of trauma, tolerance for involuntary recall experiences, amount and quality of social support, avoidance behaviour), emotional processing can be successful and stress symptoms decrease. In other cases, emotional processing is inhibited or becomes chronic (Brewin, 1989; Brewin et al., 1996; Brewin, 2001).

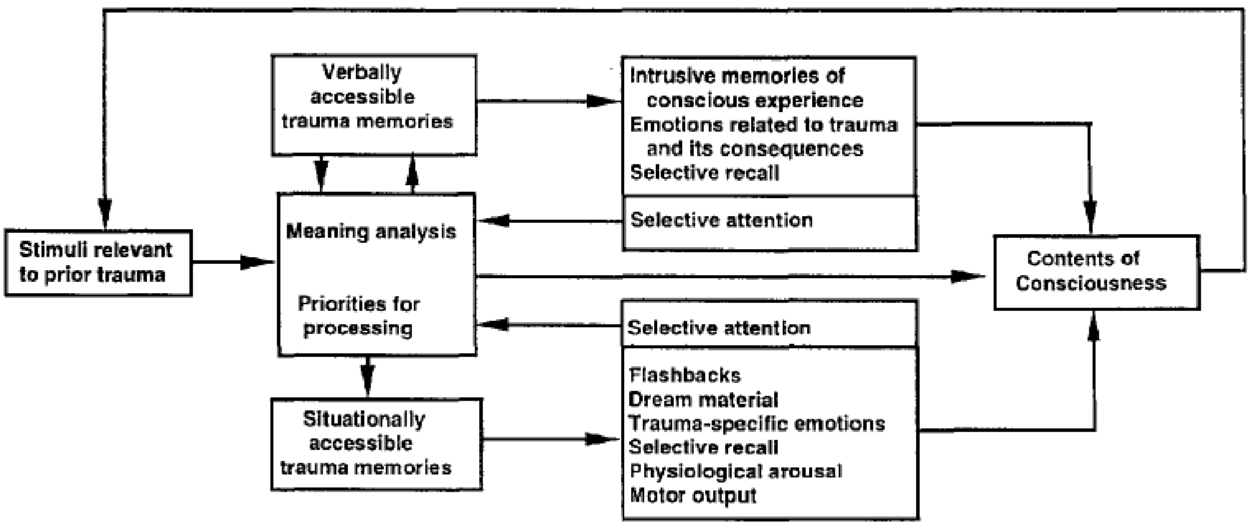

Figure 2. Model reprinted from Brewin, Dalgleish, and Joseph (1996).

It is noted here that the DRT (Brewin, 1989; Brewin et al., 1996; Brewin, 2001) and the cognitive model of PTSD (Ehlers & Clark, 2000) differ in some respects. Whereas DRT provides a detailed account of peri-traumatic processing, the focus of the cognitive model of PTSD lies in the concept of “current threat” and negative appraisals in relation to the traumatic event and its consequences. DRT (Brewin, 1989; Brewin et al., 1996; Brewin, 2001) describes different outcomes of peri-traumatic information processing and discusses possible neurological correlates, whereas the cognitive model of PTSD (Ehlers & Clark, 2000) focuses more on clinical implications for the treatment of PTSD. However, there is a convergence in that both models are based on theories that describe "normal" memory processes (e.g., Conway & Pleydell-Pearce, 2000). Furthermore, the concepts of VAMs and SAMs in DRT are closely related to the idea of data-driven processing and conceptual processing in the cognitive model of PTSD, respectively. What is most important for the purpose of the current chapter, as argued by Holmes & Bourne (2008), is the idea that intrusive images stem from a sensory form of processing with a relative lack of conceptual processing.

An empirical view on information processing theories of PTSD

In a recent review of experimental investigations of intrusion development, Holmes and Bourne (2008) proposed an empirical model based on information processing theories of PTSD. The model simplifies and explicates the overlap between the DRT (Brewin et al., 1996; Brewin, 1989, 2001) and the cognitive model of PTSD (Ehlers & Clark, 2000) to aid the generation of specific and testable hypotheses in the study of intrusion development in trauma.

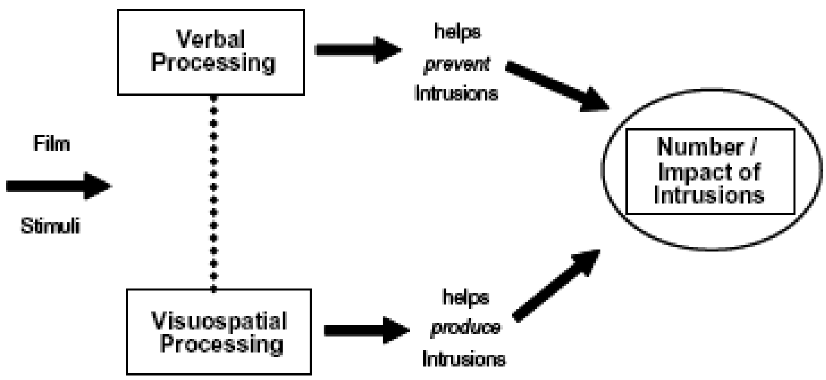

Figure 3. Model reprinted from Holmes & Bourne (2008).

The empirical model by Holmes and Bourne (2008) proposes that memory representations become intrusive when the balance between peri-traumatic visuospatial and verbal information processing is shifted towards the first. Importantly, both types of information processing are present during encoding, and it is the relative balance that accounts for the subsequent intrusive experiences. Thus, during a traumatic event, information processing is in a highly perceptual form, relatively lacking conceptual processing, leading to involuntary recall in the form of intrusive images. According to this assumption, an increase in intrusive images occurs by either enhancing perceptual processing or by interfering with verbal processing. A decrease in intrusive images occurs by either interfering with perceptual processing or by enhancing verbal processing. With regard to perceptual processing, it is noted that information of all sensory modalities (smell, vision, hearing, touch and taste) is important. However, since traumatic intrusions are mainly visual in nature (e.g., Speckens et al., 2007), the empirical model by Holmes and Bourne (2008) as well as laboratory studies of intrusion development have mainly focused on visual perceptual processing.

In sum, theoretical models of PTSD (i.e., Ehlers & Clark, 2000; Brewin et al., 1996; Brewin, 1989, 2001) are useful for a complex understanding of PTSD symptoms that go beyond the re-experiencing criterion. With regard to empirical research, a simpler model as proposed by Holmes and Bourne (2008) is useful for formulating clear and testable hypotheses on circumstances under which memory representations become intrusive.

Empirical Investigations of Intrusive Trauma Memories

Trauma film paradigm

One obvious challenge in studying the cognitive mechanisms of intrusive images is that in the case of PTSD, the traumatic event already happened. That is, it is difficult to systematically study encoding processes or even psychological responses in the early aftermath of a traumatic event. Obviously, there are ethical reasons why a traumatic event cannot be simulated. Therefore, experimental studies have used analogue traumatic situations like aversive film clips to study intrusion development.

In the 'trauma film paradigm' (Holmes & Bourne, 2008), participants view a ‘trauma film’ as an analogue traumatic event under controlled circumstances. A trauma film usually depicts events that can be defined as traumatic according to the DSM-IV-TR (APA, 2000): involving actual or threatened death, serious injury or a threat to the physical integrity of the self or others (Criterion A; APA, 2000). For example, one often used trauma film (Steil, 1996) shows real-life footage of the aftermath of road traffic accidents (RTAs) in which victims are severely injured or dead. Participants are typically healthy university students.

Before film viewing, measures of individual differences can be collected. Before and after film viewing, measures of state variables (e.g., mood) are administered to check the impact of the film. Participants are then instructed to report any intrusive images of the film in a diary for a period of time, usually one week, and then return for follow-up. In the follow-up session the diary entries can be discussed and measures relating to the film (e.g., memory questionnaires) can be collected (Holmes & Bourne, 2008). To manipulate information processing during the film, participants can, for example, be instructed to view the film from a certain perspective, or perform a concurrent task that taps into differential cognitive resources.

Regardless of the clear differences between a trauma film and real trauma, there are clues indicating that the quality of the underlying mechanisms of intrusion development is comparable. Support for this notion was reviewed by Holmes (2004), suggesting that forms of involuntary recall can be placed on a continuum. On one side of the continuum, there is the involuntary recall as it is experienced in PTSD, such as the full-blown “flashbacks”. On the other side of the continuum, one can place involuntary recall from viewing a trauma film. The studies reviewed by Holmes (2004) suggest that the main features of intrusive experiences, i.e., mainly visual images of details or scenes of the trauma, are shared across the continuum. For example, it was found that London school children experienced post-traumatic stress symptoms after viewing 9-11 events on television (Holmes, Creswell, & O’Connor, 2007).

Early uses of the trauma film paradigm

Even before the acknowledgement of PTSD in the DSM-III in 1980, the trauma film paradigm was used to explore physiological stress reactions under controlled circumstances. In several experiments, Lazarus and colleagues (e.g., Lazarus & Alfert, 1964; Lazarus & Opton, 1964) studied the effect of threat from a stressful film on skin conductance and heart rate. To illustrate, in one study (Folkins, Lawson, Opton, & Lazarus, 1968), participants received three sessions of training (relaxation, simulated desensitization, or cognitive rehearsal training) or no training. After the third session, participants viewed a stressful film showing work-related accidents and applied their trained skills. The results showed differential effects for the different training conditions on skin conductance and heart rate measures. The first studies to use the trauma film paradigm to explore more psychological constructs, like involuntary recall, were done by Horowitz (1969). In these studies, it was shown for the first time that intrusive images can occur in healthy participants after a mild stressor such as an aversive film. Where Lazarus and colleagues used terms like “short-circuiting of threat” (Lazarus & Alfert, 1964; Lazarus, Opton, Nomikos, & Rankin, 1965) that are reminiscent of an early information processing view, Horowitz introduced the term “cognitive processing” in 1975 to describe how intrusive images after viewing a stressful film occurred. In one study (Horowitz, 1969) participants viewed a neutral and a stressful film and reported their subjective experiences during a distraction task after the film. The participants’ reports showed significantly more intrusive experiences from the stressful film than from the neutral film in the 24 hours following film viewing.

Recent findings exploring peri-traumatic processing

Based on the distinction between data-driven processing and conceptual processing as formulated in the cognitive model of PTSD (Ehlers & Clark, 2000), Halligan, Clark, and Ehlers (2002) manipulated information processing style during film viewing. Participants were instructed to focus on, and become absorbed by, the perceptual information (data-driven processing condition), or with the instruction to concentrate on the order and causes of the events in the film (conceptual processing condition). Intrusive experiences were measured with a questionnaire at one-week follow-up. The results showed no differences between the two conditions with regard to intrusion frequency. The authors argued that individual preferences for processing style might have overruled the experimental instructions. In other words, some people may naturally engage in more data-driven or conceptual processing than others. In the second experiment, Halligan et al. (2002; Experiment 2) tested natural groups based on a cognitive processing style screening (Ehlers, 1998). Both groups viewed a stressful film and, in line with the cognitive model of PTSD (Ehlers & Clark, 2000), participants with a more data-driven processing style reported more intrusive experiences compared to participants with a more conceptual processing style. The findings suggest that a preferred cognitive processing style is important in intrusion development but not easily manipulated by explicit instructions.

Brewin and Saunders (2001) initially set out to test the idea that peri-traumatic dissociation is related to intrusion development. The term 'dissociation' describes experiences that indicate that cognitive processes normally functioning in an integrated way can become disrupted by high stress levels. This disruption can result in a change in consciousness and perception (Holmes, 2005). Examples are feeling like being in a dream or being a character in a film, rather than having a first person experience (derealisation), or feeling disconnected from your body (depersonalization). In one condition, participants viewed a trauma film without an extra task. In the experimental condition, participants viewed the film while performing a concurrent task (tapping a complex key pattern). Participants then reported their intrusive images from the film in a diary for two weeks. It was hypothesized that the concurrent task would divide attention and thus create a situation analogous of dissociation, leading to more intrusive images. Contrary to predictions, the participants in the concurrent task condition reported fewer intrusive images than participants in the no task control condition. Holmes, Brewin, & Hennessy (2004) proposed that the concurrent tapping task had placed a demand on visuospatial processing resources that are required for the processing of visual (and spatial) information. A visuospatial task in this respect is defined as a task that requires resources of working memory for the processing of visual and spatial information (i.e., the visuospatial sketchpad; Baddeley & Hitch, 1994). By this, the visuospatial processing of the film material was reduced by a competing demand from the tapping task, leading to a decrease in intrusive images.

This “concurrent task” hypothesis led to a series of experiments further exploring a dual processing account of PTSD. In the first experiment, Holmes et al. (2004) showed participants a trauma film under one of three conditions: no extra task, with a visuospatial tapping task, or after a dot-staring task used to induce dissociation. Although the participants in the dot-staring condition reported a higher increase in state dissociation from pre- to post-film compared to the other conditions, their number of intrusive images was not significantly different from participants in the no task control condition. Participants in the visuospatial tapping condition, however, reported fewer intrusive images after one week compared to both participants in the no task control condition and the dot-staring condition. This finding replicates the effect by Brewin and Saunders (2001), in line with predictions formulated by Holmes et al. (2004).

In the second experiment, Holmes et al. (2004) varied the amount of cognitive load of the visuospatial task by having participants tap a single key, an overpractised visuospatial pattern or a complex visuospatial pattern while viewing the trauma film. In the overpractised pattern condition, participants performed the pattern tapping until they were able to perform the task effortlessly. In the complex pattern condition, participants performed the same tapping task without practice. In line with predictions, the number of intrusive images from the trauma film reported after one week was lowest in the complex visuospatial tapping condition, followed by the overpractised tapping condition. The single key tapping was not significantly different from no task.

Further evidence for the role of peri-traumatic visuospatial processing in intrusion development stems from a study by Stuart, Holmes, and Brewin (2006). Instead of performing the tapping task, participants performed an alternative visuospatial task - modelling cubes and pyramids alternately from clay. A similar task is sometimes used in clinical practice to help PTSD patients remain grounded during imaginal exposure interventions, when the trauma memory is vividly brought back to mind. Participants performed the clay task during one part of the trauma film. During the other part of the task they did not perform any concurrent task. By specifying the scene of the intrusive images in the intrusion diary, the intrusive images could be linked to a specific film part. In line with predictions, participants reported fewer intrusive images from the film part during which they were modelling clay than during which they had not performed an extra task.

The role peri-traumatic conceptual processing has also been studied. The third experiment in Holmes et al. (2004) was designed to investigate verbal processing in relation to intrusion development. Participants viewed a trauma film under one of three conditions: without an extra task, while counting backwards out loud in 3's, or while verbalizing the unfolding scenes out loud (verbal enhancement). It was hypothesized that counting backwards in 3's would increase intrusion frequency by interfering with the verbal processing of the film. Indeed, after one week, participants in the counting backwards condition reported more intrusive images from the film compared to both the no task control condition and the verbal enhancement condition. The prediction that the verbal enhancement task would decrease intrusive images was not supported. The authors note that, on closer inspection, participants in the verbal enhancement condition seemed to verbalize mainly physical aspects of the film, so the lack of a decrease could be due to low task compliance. The effect of the verbal interference task has been replicated and extended in two experiments (Bourne, Frasquilho, Roth, & Holmes, 2008); by using the instruction of counting backwards in 7's instead of 3's.

In a study by Nixon, Nehmy, and Seymour (2007), participants viewed an aversive film under one of three conditions: while having a cognitive load (having to remember a 9-digit number), while hyperventilating, or without a concurrent task. The cognitive load task was used to prevent verbal processing of the film. For the purpose of the current chapter we only report the results on the cognitive load task and the no task control condition. Intrusive images were measured immediately post-film with a free thinking task. Intrusive experiences after one week were measured with a questionnaire (Impact of Event Scale; Weiss & Marmer, 1997). In line with predictions, the participants in the cognitive load task reported more frequent intrusive images immediately post-film compared to the no task control group. However, after one week, there was no significant difference between the cognitive load group and the no task control group. Pearson, Sawyer, and Holmes (2008) tested the effect of a visuospatial task and a cognitive load task. Instead of a trauma film, participants viewed negatively and positively valenced pictures. During picture viewing, participants performed a visuospatial tapping task, a random number generation (RNG) task, or no concurrent task. RNG requires participants to say aloud numbers from 1 to 10 in a random fashion. This induces a cognitive load since the production of non-random series needs to be monitored continuously. Surprisingly, the results showed that participants in both the visuospatial tapping condition and the RNG condition showed a *decrease* in intrusive images for both negatively and positively valenced pictures after one week compared to the no task control condition. The finding that the visuospatial tapping task reduced intrusive images is in line with the information processing models of PTSD (Brewin et al., 1996; Brewin, 2001, 2003; Ehlers & Clark, 2000). However, the finding that the RNG condition also reduced intrusive images was surprising. In a further examination, Pearson et al. (2008) modulated the cognitive load of both the visuospatial task and the RNG task. The results showed that increasing cognitive load decreased intrusion frequency for both tasks.

Table 1 reviews the studies described above. Although the findings from studies manipulating visuospatial processing are rather robust, attempts to manipulate intrusion frequency through the manipulation of verbal processing have come up with conflicting results.

Table 1. *Review of recent findings on the modulation of intrusion frequency by manipulation encoding using the trauma film paradigm*

Study	*Experiment*	*Conditions*	*Measure**	*Intrusion frequency (Highest to lowest)*
Halligan, Clark, & Ehlers (2002)	1	– Data driven processing instruction – Conceptual processing instruction	Symptom questionnaire	No significant difference
	2	– Preferred data-driven processing style – Preferred conceptual processing style	Symptom questionnaire	1. Data-driven processing 2. Conceptual processing
Brewin & Saunders (2001)		– No task – Visuospatial tapping	Two-week Intrusion diary	1. No task 2. Visuospatial tapping
Holmes, Brewin, & Hennessy (2004)	1	– No task – Visuospatial tapping – Dot-staring	Intrusion diary	1. No task and dot-staring 2. Visuospatial tapping
	2	– No task – Single key tapping – Overpractised tapping – Complex pattern tapping	Intrusion diary	1. No task and single key tapping 2. Overpractised tapping 3. Complex pattern tapping
	3	– No task – Counting backwards in 3's – Verbalizing film scenes	Intrusion diary	1. Counting backwards in 3's 2. No task and verbalizing scenes
Stuart, Holmes, & Brewin (2006)		– No task – Modelling clay	Intrusion diary	1. No task 2. Modelling clay

(Table 1 continued)

Bourne, Frasquilho, Roth, & Holmes (submitted)	1	– No task – Counting backwards in 3's – Visuospatial tapping	Intrusion diary	1. Counting backwards in 3's 2. No task 3. Visuospatial tapping
	2	– No task – Counting backwards in 7's	Intrusion diary	1. Counting backwards in 7's 2. No task
Nixon, Nehmy, & Seymour (2007)		– No task – Cognitive load (– hyperventilation)	– Post-film free thought – Questionnaire (IES)	Post-film free thought: 1. Cognitive load 2. No task Questionnaire (IES): 1. No task and cognitive load
Pearson, Sawyer, & Holmes (2008)	1	– No task – Visuospatial tapping – Random number generation (RNG)	Intrusion diary	1. No task 2. Visuospatial tapping and RNG
	2	– No task – Single key tapping – Complex pattern tapping – Articulatory suppression – RNG	Intrusion diary	1. No task 2. Single key tapping and articulatory suppression 3. Complex pattern tapping and RNG

* At one week unless indicated otherwise

Recent findings exploring post-traumatic processing

The large majority of research on information processing models of PTSD has focused on peri-traumatic processing. To date, only a few studies have looked at post-traumatic processes, although this is important for several reasons. First, there is a theoretical importance. Is the distinction between visuospatial and verbal processing as relevant post-traumatically as it is thought to be peri-traumatically? And can consolidation of information in memory still be manipulated? Second, if post-traumatic processing can be manipulated this has implications for possible treatment or prevention interventions. The latter reason is especially important, since studies on the effectiveness of intervention immediately post-trauma are rather mixed, with some studies showing an improvement in PTSD symptoms (Sijbrandij et al., 2007), but some showing a disturbing worsening of stress symptoms (e.g., Bisson, Jenkins, Alexander, & Bannister, 1997; Mayou, Ehlers, & Hobbs, 2000). Importantly, clinical guidelines of the treatment of PTSD (National Institute of Clinical Excellence, 2003) do not recommend interventions immediately post-trauma for aforementioned reasons. Research on information processing post-trauma could be helpful in shedding light on these discrepancies and possibly aid in the development of effective prevention interventions.

The few studies that have used the trauma film paradigm to look at post-film effects differ in the extent to which they directly assess an information processing account as outlined in this chapter. As noted, information processing models of PTSD like the DRT (Brewin et al., 1996; Brewin, 1989, 2001) and the cognitive model of PTSD (Ehlers & Clark, 2000) come down to the idea that the initial encoding of traumatic information is a major factor in the development of intrusive traumatic images. The event-specific knowledge, often raw sensory details, of the traumatic event is not further integrated in the autobiographical knowledge base (Conway & Pleydell-Pearce, 2000), and is therefore prone to automatic activation through internal or external stimuli that are similar in sensory qualities. The implication is that if the trauma memory becomes more integrated within autobiographical memory, intrusive images should decrease.

Butler, Wells, and Dewick (1995) explored the effect of worry and imagery on intrusive images after film viewing. Participants were instructed to either worry about the film in verbal form (worry group), imagine the film in mental pictures (imagery group), or take some time to settle down (control group) after the film. Participants reported intrusive images of the film in a diary. After three days, participants in the worry group reported significantly more intrusive images from the film compared to both the imagery group and the control group. Although this study does not explicitly test an information processing account of PTSD, their results do have implications for post-trauma processing. Although worrying is a verbal activity, it is very preoccupied with questions about what could have happened and possible (negative) implications. Worry, then, is importantly distinct from verbal conceptual processing as it may not reflect contextualizing a stressful event in a helpful way. With regard to post-film perceptual processing, one recent study by Holmes, James, Deeprose, and Coode-Bate (2009), showed that performing a visuospatial task (playing Tetris) after a trauma film also successfully reduces intrusive images from the film compared to no task. The final study that is discussed here is unique in that it is one of the first studies to use the trauma film paradigm to explore a possible application for clinical practice. Cognitions about a traumatic event and its consequences are important in the maintenance of intrusive images (Ehlers & Clark, 2000). A frequently used measure of post-traumatic cognitions is the PTCI (Post Traumatic Cognitions Inventory; Foa et al., 1999). Based on this questionnaire, Mackintosh, Woud, Postma, Dalgleish, and Holmes (submitted) created a trauma specific Cognitive Bias Modification (CBM) training (Mathews & Mackintosh, 2000) used for the indirect training of participants for a positive or negative interpretation of analogue post-traumatic stress symptoms. Participants were presented with incomplete, ambiguous scenarios based on items of the PTCI Self-scale. The scenarios contained typical post-trauma cognitions, e.g., how well a person thinks he/she can cope with the trauma or whether he/she beliefs to have acted adequately during the traumatic event. Participants were instructed to complete these scenarios in either a positive or negative way. It was hypothesised that this training would induce an interpretation bias towards analogue trauma symptoms compatible to the valence of the participants' training condition. After the training (Experiment 1), participants viewed a trauma film and then recorded their intrusive images of the film in a one-week diary. The results showed that although there were no differences in the frequency of intrusive images, the distress that accompanied the intrusive images was significantly lower in the positive training condition compared to the negative training. In a second experiment, the same trauma CBM procedure was applied after film viewing. This time, participants in the positive condition reported a lower intrusion frequency, but not intrusion distress, compared to the negative condition. However, when intrusive thoughts and images were included that could not be traced back directly to the film, like in Experiment 1, differences in distress emerged in the same pattern as in Experiment 1. Overall, these findings indicate that the trauma film paradigm could prove to be useful for testing clinical applications. Further, the study illustrates that negative cognitions about ones reactions to a traumatic event relate to both a higher frequency of intrusive images as well as higher distress associated with the intrusive thoughts and images. These results are obviously in line with the role of appraisals in the onset and maintenance of PTSD, as described in the cognitive model of PTSD by Ehlers and Clark (2000).

Conclusions and discussion

The goal of this chapter was to provide and review an information processing perspective on involuntary recall after psychological trauma. Historically, the acknowledgement of PTSD as a psychiatric disorder has not been straightforward, partly due to political and social factors. However, even before this, PTSD theory and experimental research has been innovative, especially when we consider that this chapter has only addressed the very specific topic of intrusive image-based trauma memories.

As noted, an influential perspective on involuntary recall in PTSD comes from an information processing tradition. Two important information processing theories were discussed, namely the dual representation theory by Brewin and colleagues (1996, 1989, 2001) and the cognitive model of PTSD by Ehlers and Clark (2000). Although they differ on several aspects, both theories converge on the idea that the initial encoding of traumatic information in memory lies at the heart of involuntary recall in PTSD. With this in mind, Holmes and Bourne (2008) developed a pragmatic model of PTSD to guide the design and interpretation of experimental studies of intrusive images. In light of the successful results on visuospatial processing and mixed findings with regard to verbal processing, the model needs further study.

In relation to providing support for the information processing view of involuntary recall in PTSD, the trauma film paradigm has proven to be a useful tool to study causal influences of underlying mechanisms that are not accessible by studying actual PTSD patients.

With regard to peri-traumatic information processing, research findings continue to provide support for the idea that intrusive images rely on an image-based memory system that stems from initial encoding of trauma information that is not integrated within autobiographical memory. Studies showing that specific interference of peri-traumatic visuospatial processing (e.g., Halligan et al., 2002; Brewin & Saunders, 2001; Holmes et al., Experiment 1 and 2, 2004; Stuart et al., 2006; Pearson et al., 2008) reduces the frequency of intrusive images from a trauma film provide support for this. Findings related to peri-traumatic verbal processing have yielded mixed results, with some studies showing that interfering with verbal processing reduces intrusive images (e.g., Holmes et al., Experiment 3, 2004; Nixon et al., 2007; Bourne et al., 2008), and one showing the opposite effect (e.g., Pearson et al., 2008).

One exciting field of research that has started to emerge is the study of post-traumatic processing. So far, findings are encouraging in that a visuospatial task after film viewing induced a reduction in subsequent intrusive images (Holmes et al., 2008). Because the aftermath of trauma defines the moment when PTSD symptoms are presented, studies like the CBM training by Mackintosh et al. (submitted) are promising for possible application in clinical practice.

We started this chapter by emphasizing the importance of autobiographical memory, how it gives us a personal identity and a life story to tell. It is not difficult to see how memory-related problems in trauma, such as intrusive re-experiencing, can have a profound impact on the life of an individual. Therefore, the study of post-traumatic stress symptoms such as intrusive images remains highly important.

Chapter 3

Motion effects on intrusion development

This chapter is based on Krans, J., Näring, G., Holmes E. A., & Becker, E. S. (2010). Motion effects on intrusion development. *Journal of Trauma and Dissociation, 11*, 73-82.

Abstract

Analogue studies on intrusion development have found that visuospatial tasks performed during the encoding of aversive information reduce subsequent intrusion development. However, these studies cannot rule out a physical explanation in terms of simple movement. In the current study we addressed this issue. Healthy participants viewed an aversive film while performing a visuospatial movement task, a configurational movement task, or no task. Intrusive images from the film were reported in a diary during the week following film viewing. In line with an information-processing account of posttraumatic stress disorder, intrusion frequency was significantly reduced by the visuospatial movement task but not the configurational movement task compared to no task. This finding supports the specific role of visuospatial processing in intrusion development.

Introduction

Intrusive images can be defined as images of a traumatic event that come into mind uncontrollably. Intrusive images in posttraumatic stress disorder (PTSD) are mainly of a visual nature (Speckens, Ehlers, Hackmann, Ruths, & Clark, 2007), and visuospatial processing is thought to play a critical role in intrusion development. During extreme stress, information processing is thought to shift toward more visuospatial processing, resulting in image-based trauma representations that are prone to automatic intrusive activation (Holmes & Bourne, 2008).

Experimental studies have shown that performing a visuospatial task (e.g., complex pattern tapping) during the encoding of an aversive film reduces subsequent intrusion frequency (Brewin & Saunders, 2001; Holmes, Brewin, & Hennessy, 2004; Stuart, Holmes, & Brewin, 2006). However, movement per se is confounded with the visuospatial aspect in these studies. Hagenaars, Van Minnen, Holmes, Brewin, and Hoogduin (2008) found that participants who were instructed not to move during an aversive film reported more intrusive images after 1 week compared to participants who could move freely. This gives rise to the idea that movement per se could have the reverse effect. A critical test is needed of the effects of visuospatial versus non-visuospatial movement on intrusion development.

Configurational movements by definition rely on *propriospatial* information and not on visuospatial processing. Smyth, Pearson, and Pendleton (1988) found that performing a visuospatial tapping task interfered with visuospatial recall but not with movement recall. Conversely, configurational movement tasks (continuously tapping body parts with the hands, hand squeezing) interfered with configurational but not visuospatial recall (Smyth et al., 1988; Smyth & Pendleton, 1989).

In terms of suitability for the current study, the body-tapping task in Smyth et al. (1988) could interfere with film viewing, and the squeezing task used by Smyth and Pendleton (1989) might affect heart rate, which has been shown to relate to intrusion development (Holmes et al., 2004). Therefore, we chose a complex gum-chewing task. This involved chewing the gum from the left jaw to the front teeth, the right jaw, the left jaw, and back again continuously. This task does not interfere with film viewing, is unlikely to have a significant effect on heart rate, and involves propriospatial but not visuospatial imagery. Research on infant imitation behaviour supports the idea that tongue movements rely on a proprioceptive system and not on visuospatial processing (Meltzoff & Moore, 1983a, 1983b, 1989).

We also included measures of dissociation and cognitive avoidance in this study. Dissociation is described as “a disruption in the usually integrated functions of consciousness, memory, identity, or perception” (American Psychiatric Association, 2000, p. 519). Retrospective studies (e.g., Ozer, Best, Lipsey, & Weiss, 2003) and prospective studies (Engelhard, Van Den Hout, Kindt, Arntz, & Schouten, 2003; Murray, Ehlers, & Mayou, 2002) have shown a relation between dissociation and intrusion development, and earlier studies have shown that dissociation can be induced by an aversive film (Brewin & Saunders, 2001; Holmes et al., 2004).

The main goals of the present study were (a) to replicate the finding of lower intrusion frequency from a concurrent visuospatial task (complex pattern tapping) during the encoding of an aversive film and (b) to distinguish between the effects of visuospatial versus non-visuospatial movement on intrusion development using a configurational task. Based on an empirical account of information-processing in PTSD (Holmes & Bourne, 2008), we expected that the visuospatial task would result in lower intrusion frequency than both no task and the configurational task, which in turn was expected not to affect intrusion frequency compared to no task. If both movement tasks reduce intrusion frequency compared to no task, this would count against the specific role of visuospatial processing in intrusion development (Holmes et al., 2004).

Method

Participants

Participants, all psychology students, were recruited on a university campus using flyers and posters. As required by the ethical committee (Commissie Mensgebonden Onderzoek [CMO], Approval No. 2005/063), flyers and posters contained information about the violent nature of the film. Participants received 24 Euros for participating. Exclusion criteria were panic attacks, panic disorder, PTSD, major depressive episode (current or lifetime), blood phobia, history of fainting, and history of road traffic accidents. No participants dropped out. Data were collected from 54 participants (34 women, 20 men).

Participants' mean age was 21 years, 9 months (*SD* = 3 years, 10 months). Age and gender were comparable across conditions.

The visuospatial tapping task, mood questionnaire, attention rating, cued recall and recognition memory tests, diary compliance rating, and intrusion diary were the same as in Holmes et al. (2004). All questionnaires were presented on a personal computer using Perseus® software (Version 6).

Materials

Aversive film. The film contained four scenes of the aftermath of real life road traffic accidents showing car wrecks, bloody wounds, and dead bodies being moved (Hagenaars et al., 2008; Steil, 1996). The film was projected onto a smooth white wall, and sound was presented through headphones.

Experimental tasks. A 5 × 5 matrix keyboard with letters running from *A* to *Y* ("Moar box") was used for the visuospatial tapping task. Participants continuously tapped the complex pattern *JYPVA* as fast and as accurately as possible during the film while the tapping hand was out of sight. For the configurational task, participants chewed sugar-free gum (peppermint flavour). Participants in the visuospatial and the configurational movement conditions practiced the task for 1 min before the film was started. All participants were instructed to view the film as if they were witnesses, not to look away, and to pay full attention to the film. To enhance task compliance we told participants that they were being videotaped (a recording was not actually made).

Measures

Emotional impact of the film. A mood questionnaire was used to rate current happiness, fear, horror, depression, and anger on a scale from 0 to 10 (0 = not at all, 10 = extremely). The Dutch version of the State–Trait Anxiety Inventory (STAI-S; Van der Ploeg, 1980) was used to assess state anxiety. It contains 20 items about the individual's current level of anxiety, with ratings from 1 (almost never) to 4 (almost always). The STAI has satisfactory reliability and validity (Van der Ploeg, 1980).

Dissociation. Trait dissociation was measured with the Dutch version of the Dissociative Experiences Scale–Revised (DES-II; Bernstein & Putnam, 1986). The DES-II consists of 28 items and rates the frequency of dissociative phenomena on an 11-point scale with a 10% interval from 0% (never) to 100% (always). It has satisfactory reliability and validity (Bernstein & Putnam, 1986; Van IJzendoorn & Schuengel, 1996). State dissociation was measured with the Dutch version of the self-report Dissociative States Scale (DSS; Bremner et al., 1998). It contains 19 items rating current dissociative phenomena on a 5-point scale from 0 (not at all) to 4 (very much). Reliability and validity are sufficient (Bremner et al., 1998).

Attention and memory for the film. Attention was rated on an 11-point scale (0 = not at all focused on the film, 10 = attention completely focused on the film) as an indirect measure of task difficulty. The cued recall memory test contained two to four open-ended questions per scene (e.g., “What body parts were wounded and bleeding when the woman was freed from the minivan and was lying down on the stretcher?”). The recognition memory test contained three to five statements per scene (e.g., “The paramedics covered the students’ head with bandage” yes/no).

Compliance and demand. Diary compliance was rated on a scale from 0 (never forgot to write down the intrusion) to 10 (always forgot to write down the intrusion). Participants were asked about the perceived goal of the study with an open-ended question.

Cognitive avoidance. A single-item question (“During the last week, how strongly have you tried to push away or suppress thoughts and images of the film?”) was rated on a 7-point scale (1 = not at all, 7 = very strongly). The item correlates highly (r = .62, p < .001; Krans, Näring, Holmes, & Becker, 2009b) with the avoidance subscale of the Impact of Event Scale (Horowitz, Wilner, & Alvarez, 1979), and similar single-item avoidance measures have been used in previous research (e.g., Becker, Rinck, Margraf, & Roth, 2001).

Intrusive images. Intrusive images were recorded in a one-week diary. Participants indicated whether the intrusion was an image, a verbal thought, or both and provided a content description. Participants were required to check their entries at a fixed time every day.

Procedure

After signing informed consent, participants filled out a demographic questionnaire (age, gender, and education), the DES-II, the DSS, the STAI-S, and the mood questionnaire. Then participants received instructions according to their condition and practiced their task for 1 min. Participants were told that they could quit the experiment at any time. Participants viewed the film and then filled out the DSS, the mood questionnaire, the STAI-S, and the attention rating. During the week between the first session and follow-up, participants reported their intrusions of the film in the diary. At follow-up they filled out the cued recall and the recognition memory tests, the diary compliance rating, and an open-ended question about the goal of the study. The participants were debriefed, paid, and thanked for their participation.

Method of Analysis

For variables that showed a violation of homogeneity of variance according to Levene's statistic, the corrected t value is reported. A priori hypotheses were examined using directional tests. The number of intrusive images did not have a normal distribution, so Spearman correlations were used. For all analyses, an alpha of .05 was the level of significance. Descriptive statistics are reported in Table 1.

Results

Outliers and Task Compliance

The diary data were checked for outliers (more than 3 *SD* from the mean) using boxplots. One multivariate outlier (in the visuospatial tapping condition) was removed from the data set. One univariate outlier was changed into one unit smaller than the next extreme score in that condition (Tabachnick & Fidell, 1996).

The mean number of tapped keys and correct sequences were compared to those reported in Holmes et al. (2004; Experiment 1) with two one-sample t tests. These showed comparable performance (both ps > .05).

Control Measures

Emotional impact. A 2 Time (pre-film, post-film) x 3 Condition (control, visuospatial tapping, configurational gum chewing) mixed ANOVA was done with condition as the between-subjects factor and the mood questionnaire and STAI-S as the dependent variables. The overall within-subject effect was significant, $F(6, 46) = 13.53$, $p < .001$, $f = 1.33$, and the univariate within-subject effects were significant (all ps < .05), indicating a significant emotional impact of the film. There was no significant effect of condition or an interaction effect (both *p*s > .05).

Dissociation. A 2 Time (pre-film, post-film) × 3 Condition (control, visuospatial tapping, configurational gum chewing) mixed ANOVA with state dissociation as the dependent variable showed a significant increase from baseline to post-film, $F(1, 51) = 4.06$, $MSE = 6.31$, $p = .05$, $f = 0.27$. There was no significant effect of condition ($p < .05$) and no significant interaction effect ($p < .05$). Trait dissociation and state dissociation (pre-film, post-film, and change) were not significantly correlated with intrusion frequency (all *p*s > .05).

Attention and memory. A one-way ANOVA showed no significant difference between the conditions with regard to the attention rating for the film, $F(2, 51) = 1.48$, $MSE = 1.51$, $p = .24$, indicating that the tasks were comparable on required attention and task difficulty.

A one-way ANOVA showed a significant difference between the conditions on the cued recall memory test, $F(2, 51) = 4.40$, $MSE = 3.25$, $p = .02$, $f = 0.42$. Post hoc tests with Bonferroni correction showed a significantly better cued recall performance in the no-task control condition than the visuospatial tapping condition, $SE = .61$, $p = .01$. There was no significant difference between the configurational gum chewing condition and the other conditions, both *p*s > .05. Across conditions, cued recall performance was positively related to intrusion frequency, $r_s = .35$, $p = .01$. A one-way ANOVA showed that recognition memory performance was comparable across conditions, $p > .05$.

Cognitive avoidance. A one-way ANOVA showed no significant difference between the conditions with regard to cognitive avoidance at follow-up, $p < .05$. There was no significant correlation with intrusion frequency, although there was a trend in the predicted direction, $rs = .24$, $p = .08$, with more avoidance related to more intrusions.

Demand characteristics. None of the participants mentioned modulation of intrusion frequency by the two movement tasks when asked about the goal of the study.

Table 1. *Descriptive statistics for each experimental condition*

		No task		*Visuospatial tapping*		*Configurational gum chewing*	
Measure		*M*	*SD*	*M*	*SD*	*M*	*SD*
Total key presses		-	-	807.19	404.99	-	-
Correct sequences		-	-	148.31	62.67	-	-
Intrusion frequency		4.28	4.79	1.64	1.86	2.63	1.61
Happiness	pre-film	7.47	1.31	8.13	0.72	7.95	0.85
	post-film	5.47	1.87	6.38	1.75	5.89	2.21
Anxiety	pre-film	1.89	1.41	2.13	1.41	1.89	1.41
	post-film	2.11	1.60	3.38	2.36	2.58	2.01
Horror	pre-film	1.16	0.50	1.63	0.89	1.05	0.23
	post-film	2.89	2.18	4.63	2.78	4.00	2.94
Depressed mood	pre-film	1.58	0.61	1.88	1.03	2.00	1.53
	post-film	2.89	2.05	4.00	1.93	3.26	2.51
Anger	pre-film	1.16	0.38	1.69	1.01	1.21	0.54
	post-film	1.32	0.95	2.63	2.25	2.37	2.31
State anxiety (STAI-S)	pre-film	31.68	5.97	30.31	5.88	31.53	7.31
	post-film	36.63	6.92	37.50	8.85	36.11	9.67
State dissociation (DSS)	pre-film	21.00	1.83	21.44	3.24	21.95	3.01
	post-film	21.74	3.46	23.00	7.27	22.58	2.97
Trait dissociation (DES-II)		4.72	3.07	5.02	4.04	6.62	3.98
Attention		8.68	1.06	8.13	1.20	8.05	1.39
Cued-recall		7.00	1.56	5.19	2.34	6.21	1.47
Cued-recognition		11.47	1.90	10.81	1.60	11.00	1.86

Note: dashes stand for 'not applicable'

Intrusion Modulation

As predicted, participants in the visuospatial tapping condition reported significantly fewer intrusive images of the film compared to participants in the no-task control condition, corrected $t(24.09) = 2.21$, $p = .02$ (one-tailed), $d = 0.78$; and the configurational gum-chewing condition, $t(33) = 1.70$, $p = .05$ (one-tailed), $d = 0.57$. The difference between the configurational gum-chewing condition and the no-task control condition was not significant, corrected $t(21.99) = 1.42$, $p = 0.17$ (two-tailed).

We performed a hierarchical regression analysis to determine whether cued recall contributed to the prediction of intrusive images independent of experimental condition. The first block contained two dummy variables representing experimental condition. The second block contained the cued recall memory test. The first block reached significance, Fchange(2, 51) = 3.13, $p = .05$, $R2$ change = 0.11. The second block did not increase the prediction significantly ($p < .05$). Thus, cued recall memory performance did not predict intrusive images after experimental condition was controlled for.

Discussion

We aimed to replicate the finding that a visuospatial task performed during encoding protects against intrusion development after viewing an aversive film. We investigated whether visuospatial movement specifically or movement in general reduces intrusion development. Our results show that the visuospatial tapping task significantly reduced intrusion frequency compared to both the no-task control condition and the configurational gum-chewing condition, whereas the latter did not reduce intrusion frequency compared to no task. Attention or task difficulty did not seem to explain this difference. Our findings support an information-processing account of PTSD (Holmes & Bourne, 2008). Although it has been found that non-movement is related to an increase in intrusion frequency (Hagenaars et al., 2008), our results do not support an opposite effect. It is interesting that performance on the cued recall memory test after one week was positively related to the number of intrusive images. This fits an explanation in which the visuospatial tapping condition reduces visuospatial encoding, affecting both intrusion frequency and deliberate recall.

With regard to dissociation, our results replicate the finding by Holmes et al. (2004) that an aversive film can induce spontaneous dissociation. However, our effect was modest at best. Neither state nor trait dissociation was related to the number of intrusive images in our study. Perhaps only higher levels of dissociation lead to intrusion development, and this was not induced in this analogue experiment.

The use of concurrent tasks in order to reduce intrusive images has also been endorsed by eye movement desensitization and reprocessing research. In a comprehensive series of experiments, Gunter and Bodner (2008) showed that vividness and emotionality of memory decreased according to the cognitive load of the task regardless of modality (visuospatial or verbal). This seems to contradict our present argument of a modality-specific effect of visuospatial processing. However, an important difference is that our study focused on *encoding* processes, whereas eye movement desensitization and reprocessing focuses on *recoding* of traumatic memories. A systematic study of modality (a)specific effects on intrusive memories directly comparing encoding and recall processes has not yet been done and would be an interesting future research direction.

The present study has some specific limitations. The gum-chewing task was created on the basis of the literature of configurational and proprioceptive movement, but we did not specifically test the assumption that it is not a visuospatial task. This leaves open the possibility that it may involve a visuospatial component after all, although our findings and previous research do not support this. Furthermore, we did not control for several measures that are thought to be related to intrusion development, such as repressive coping, neuroticism, and schizotypy. Avoidance was measured with a single item instead of a validated measure, for example the Impact of Event Scale (Horowitz et al., 1979).

In sum, our results suggest that it is not movement per se but visuospatial movement specifically that reduces intrusive images after one views an aversive film. This important finding confirms a central tenet of information-processing theories of PTSD that suggest that visuospatial processing rather than movement per se underlies intrusion development.

Chapter 4

Count out your intrusions: Effects of verbal encoding on intrusive memories

This chapter is based on Krans, J., Näring, G., & Becker, E. S. (2009). Count out your intrusions: Effects of verbal encoding on intrusive memories. *Memory, 17*(8), 809-815.

Abstract

Peri-traumatic information processing is thought to affect the development of intrusive trauma memories. This study aimed to replicate and improve the study by Holmes, Brewin, and Hennessy (2004, Exp. 3) on the role of peri-traumatic verbal processing in analogue traumatic intrusion development. Participants viewed an aversive film under one of three conditions: counting backwards in 3s (‘‘verbal interference’’), verbalising emotions and thoughts (‘‘verbal enhancement’’), or without an extra task. A dual-process account of PTSD would predict that verbal interference would increase intrusion frequency compared to no task, whereas verbal enhancement would lead to a decrease. In contrast, mainstream memory theory predicts a decrease in intrusion frequency from any concurrent task that diverts attention away from the trauma film. The main finding was that the verbal interference task led to a decrease in intrusive memories of the film compared to the other two conditions. This finding does not support a dual-process account of PTSD, but is in line with general theories of memory and attention.

Introduction

A hallmark feature of post-traumatic stress disorder (PTSD) is re-experiencing the trauma through distressing intrusive memories (DSM-IV-TR; American Psychiatric Association, 2000). Distortions in peri-traumatic information processing have been suggested as an important factor in intrusion development (Holmes & Bourne, 2008). The present study aimed to test the effect of interference versus enhancement of verbal processing during encoding of an aversive film on the frequency of subsequent intrusive memories.

The dual representation theory of PTSD (DRT; Brewin, Dalgleish, & Joseph, 1996) distinguishes between (a) trauma memory representations from conscious processing that can be deliberately retrieved (VAMs), and (b) image-based trauma memories (SAMs) that are automatically activated by perceptually similar cues and give rise to intrusive memories. According to DRT, conscious processing is impaired during high stress, leading to more SAMs than VAMs, which finally leads to intrusive trauma memories. Peri-traumatic verbal processing has been suggested to underlie the formation of VAMs (Holmes & Bourne, 2008; Holmes et al., 2004). Interfering with peri-traumatic verbal processing, then, should increase intrusion frequency, whereas enhancing verbal processing should decrease intrusion frequency by modulating VAM information. Additionally, verbal interference should decrease deliberate recall whereas verbal enhancement should increase deliberate recall compared to a no-task control condition.

More general theories of memory and attention (e.g., Baddeley & Hitch, 1994; Cowan, 1995; Conway & Pleydell-Pearce, 2000; Rubin, 2006; Kirkegaard Thomsen & Berntsen, 2009) suggest it depends on the retrieval process whether a memory will be intrusive or deliberately recalled (Rubin, Boals, & Berntsen, 2008). For example,

the self-memory-system (SMS) model (Conway, Singer, & Tagini, 2004) suggests that (traumatic) information is stored in its raw near-sensory form in the episodic memory system. Because of its threatening nature, traumatic information is not readily integrated into the autobiographical memory knowledge base and therefore automatic activation of traumatic episodic memories (i.e., intrusions) is not inhibited. Traumatic information is not stored in separate systems (e.g., VAMs and SAMs) but it lacks the natural integration into the autobiographical knowledge base. In terms of encoding, additional cognitive load generally reduces encoding of the film (Baddeley & Hitch, 1994). Thus, verbal interference during film viewing should decrease both intrusion development and deliberate recall of the film.

The ‘‘trauma film paradigm’’ (see Holmes & Bourne, 2008, for a review) was developed to study peri-traumatic information processing. Typically, healthy participants are presented with an aversive film while performing a concurrent task. Participants report intrusive memories from the film in a 1-week diary. Studies have supported the role of visuospatial-perceptual information processing in intrusion development (e.g., Krans, Näring, Holmes, & Becker, 2010) but the role of verbal-conceptual processing is less well studied. This is surprising because the study of peri-traumatic verbal processing is critical for the dual-processing account. Showing that intrusion frequency can increase through interference with peri-traumatic verbal processing would argue against a general distraction argument. In an important study, Holmes et al. (2004, Exp. 3) presented participants with an aversive film under one of three conditions: while counting backwards in 3s (‘‘verbal interference’’ task), while verbalising the impact of the film (‘‘verbal enhancement’’), or with no extra task. Predictions were based on DRT (Brewin et al., 1996) and, in line with this, participants in the counting backwards condition reported significantly more intrusive memories from the film compared to the control condition. The verbal enhancement condition showed a non-significant trend towards more intrusions. However, on closer inspection it appeared that participants in the latter condition were verbalising physical features of the film, which is not thought to promote verbal-conceptual processing. The Holmes et al. (2004) study is important since it suggests that mere distraction is not an explanation for the results obtained in other trauma film paradigm studies. However, the results need to be replicated and the dual-processing account needs to be contrasted with general memory and attention theory. Finally, participants did not perform the verbal enhancement task as intended and this task needs to be improved.

The present study aimed (a) to replicate the study by Holmes et al. (2004; Exp. 3) while contrasting dual-processing and mainstream memory views, and (b) to improve the verbal enhancement task using more extensive training. Participants viewed an aversive film under one of three conditions: counting backwards in 3s (verbal interference), verbalising the impact of the film (verbal enhancement), or no task. Participants reported intrusive memories of the film in a 1-week diary. Results in line with the DRT (Brewin et al., 1996) would be: (a) a decrease in intrusive memories and an increase in deliberate recall of the film in the verbal enhancement condition compared to the no-task control condition and the verbal interference condition; and (b) an increase in intrusive memories and a decrease of deliberate recall in the verbal interference condition compared to both other conditions. However, more general theories of autobiographical memory (e.g., Conway & Pleydell-Pearce, 2000) would predict a decrease in intrusive memories and deliberate recall in the verbal interference condition compared to the no-task-control condition and the verbal enhancement condition. No specific difference would be expected between the verbal enhancement and the no-task-control condition as attention is film-related in both conditions.

Method

This study has been approved by the ethical committee (CMO 2005/063).

Participants

Participants, all psychology students, were recruited by flyers and posters that contained information about the violent content of the film. They received credit for participation. Data from 76 participants (11 men and 65 women) were collected (age M = 21.84 years, range 18 30). Participants were screened for panic attacks, panic disorder, PTSD, major depressive episode, psychotic episode, blood phobia, history of fainting, and a history of car accidents. No students had to be excluded.

Materials

Aversive film. The film consisted of three clips: (1) a female student in the aftermath of a traffic accident being medically attended to while crying out in pain (Steil, 1996; 2 minutes 6 seconds); (2) a mother in a WWII concentration camp forced to choose which one of her two children will be killed (from the film Sophie's Choice; 2 minutes 32 seconds); and (3) several short scenes showing mortally wounded children, faces burned with napalm, American soldiers talking about killing Iraqi citizens, and a woman crying out to Allah (from the documentary Fahrenheit 911 by Michael Moore; 2 minutes 10 seconds). The film was projected onto a smooth white wall with sound presented through headphones.

Experimental tasks. All participants were instructed to pay full attention to the film as if being a witness. Participants in the verbal processing conditions received task training. For verbal enhancement, participants were instructed to verbalise their emotions, sensations, and thoughts during the film. An example was provided with a correct verbalisation (emotion, sensory experience, or thought) and an incorrect verbalisation (physical feature). Participants practised in the presence of the experimenter, who stopped and corrected the participant in a friendly way in the case of an incorrect verbalisation. When participants fell silent they were encouraged to continue verbalising out loud. Practice continued until the participant was able to perform the task without error for 1 minute. Participants in the verbal interference condition were instructed to count backwards in 3s from 958 during the film. To practise, participants counted backwards in 3s from 100 in the presence of the experimenter. In the case of an error, the experimenter stopped and corrected the participant in a friendly way. Participants then restarted counting from 100 until they reached number 1 or 1 minute had passed. When participants fell silent they were encouraged to continue counting out loud. During the film, an audio recording was made in all conditions with an unobtrusive microphone.

Measures

Emotion. The mood questionnaire (Holmes et al., 2004) was used to rate current happiness, anxiety, horror, depression, and anger on an 11-point scale (0 = not at all, 10 = extremely). The State-Trait Anxiety Inventory (STAI; Van der Ploeg, 1980) was used to assess state anxiety with 20 items (1 = almost never, 4 = almost always). It has satisfactory reliability and validity (Van der Ploeg, 1980).

Intrusive memories. Participants reported their intrusive memories in a 1-week diary (Holmes et al., 2004). ''Intrusions'' were defined as spontaneously occurring unwanted memories of the film clips. It was emphasised that deliberate thinking about the film did not count as an intrusion. Participants were instructed to write down every occurrence immediately and check the diary at the same time every day.

Control measures

Attention and memory. Attention for the film was rated on a single item (0 = not at all, 10 = completely focused). The recognition test contained nine statements with a true/false format. The cued-recall test contained nine open-ended questions (e.g., ‘‘What was the student that was medically attended to wearing?’’).

Diary compliance and demand characteristics. Diary compliance was rated on a scale from 0 (never forgot to write down the intrusion) to 10 (always forgot to write down the intrusion). The perceived goal of the study was asked for with an open-ended question.

Procedure

After screening, participants signed an informed consent form. Participants were randomly assigned to one of the three conditions and were tested individually. The STAI-S and mood questionnaire were administered before and after film viewing. Participants in the verbalisation conditions received their task training. Then participants viewed the film, after which the attention scale was administered. At 1 week follow-up, participants filled in the cued-recall memory test, the recognition memory test, and diary compliance rating.

Statistical approach

Analyses of variance were used to test between participants effects. A priori hypotheses were examined with directional tests. The corrected t-value is reported in case of violation of Levene’s statistic. The level of significance was an alpha level of .05.

Results

Outliers were checked across and within conditions using boxplots. Four univariate outliers were identified on the number of intrusive memories. These were adjusted according to the procedure described by Tabachnick and Fidell (1996). Six univariate outliers (all scores 1 or 2) were identified for pre-film horror on the mood questionnaire. However, correction would lead to all scores being 0. To ensure variance it was decided not to adjust these scores. No multivariate outliers were detected with Mahalanobis distances (Tabachnick & Fidell, 1996). Descriptive statistics are presented in Table 1.

Randomisation and manipulation check

A multivariate ANOVA to test for pre-film differences on the mood questionnaire was not significant, $F(10, 140) = 0.75$, $p = .68$. There was no significant difference between conditions in pre-film STAI-S, $F(2, 73) = 0.76$, $p = .47$. Pre-film mood was comparable across conditions.

Audio recordings from 47 participants (88.68%) were suitable for analysis. The verbal interference condition showed $M = 5.40$ ($SD = 6.68$) errors. In the verbal enhancement condition, thoughts and emotions about the film were verbalised during 16.36% of the film, physical features during 1.95%, and participants were silent during 81.69% of the film. The number of pauses in this condition was similar to that in the verbal interference condition (see Table 1), corrected $t(41.05) = 1.22$, $p = .23$. The mean duration of the pauses was almost three times longer in the verbal enhancement condition than in the verbal interference condition, corrected $t(15.92) = 6.26$, $p < .001$, $d = 1.77$.

Control measures

Demand characteristics. Participants who recognised intrusion modulation as the perceived goal of the study were given a score of 1 on a demand variable, whereas other participants were given a score of 0. Within conditions, one-way ANOVAs were performed with demand as the independent factor and the number of intrusive memories as the dependent variable. There was no difference by demand on intrusion frequency in the no-task-control and the verbal interference condition ($p > .05$). Participants in the verbal enhancement condition who mentioned intrusion modulation ($n = 8$) reported significantly fewer intrusive memories compared to participants who did not ($n = 16$), $F(1, 22) = 6.56$, $p = .02$, $f = 0.55$.

Diary compliance. The overall diary compliance rating was $M = 1.97$, $SD = 1.38$, indicating high compliance. There was no significant difference between conditions ($p > .05$).

Intrusion frequency. The verbal enhancement condition was not significantly different from the no-task-control condition with regard to intrusion frequency, corrected $t(40.17) = 1.04$, $p = .30$ (two-tailed). Participants in the verbal interference condition showed a trend towards fewer intrusive memories compared to the no-task control condition, $t(50) = 1.80$, $p = .08$ (two-tailed), $d = 0.50$. There was no significant difference between the verbal interference and verbal enhancement condition, $t(51) = 0.85$, $p = .20$ (one-tailed). Because the number of intrusive memories in the verbal enhancement condition could be deflated due to demand characteristics, we reran the analyses for this condition with only participants who were unaware of the goal of the study. Now the verbal enhancement condition showed significantly more intrusive memories compared to the verbal interference condition, $t(28) = 2.05$, $p = .04$ (two-tailed), $d = .76$, but not compared to the no-task control condition, $t(31) = 0.22$, $p = .82$ (two-tailed).

Emotional impact. A 2 (mood questionnaire: pre- film, post-film) x 3 (condition: control, verbal interference, verbal enhancement) repeated measures MANOVA was done to test the emotional impact of the film. The within-participants test was significant, F(5, 69) = 70.37, p < .001, f = 2.26, indicating significant emotional impact of the film. There was no significant main effect of condition, F(2, 73) = 0.64, p = .53. The interaction effect was only marginally significant, F(10, 140) = 1.81, p = .06, with a significant larger decrease in happiness in the control condition compared to the verbal interference condition (p = .02).

A 2 (anxiety: pre-film, post-film) x 3 (condition: control, verbal interference, verbal enhancement) repeated measures ANOVA with STAI-S scores as the within-participants factor and condition as the between-participants factor showed a significant increase in state anxiety, $F(1, 73) = 99.75$, $p < .001$, $f = 1.17$. There was no significant main effect of condition, $F(2, 73) = 0.40$, $p = .67$, but there was a significant interaction, $F(2, 73) = 3.29$, $p = .04$, $f = 0.30$. A one-way ANOVA was performed with the change scores on the STAI-S as the dependent variable and condition as the between-participants factor. Post hoc tests (Bonferroni correction) showed a significantly smaller increase in anxiety in the verbal interference condition compared to the verbal enhancement condition, $p = .04$, but not compared to the no-task control condition, $p > .05$. The latter two conditions were not significantly different, $p = .34$.

Table 1. *Descriptive statistics for the experimental variables*

		No-task control		*Verbal interference*		*Verbal enhancement*	
Measure		*M*	*SD*	*M*	*SD*	*M*	*SD*
Intrusive images*		3.53	3.26	2.07	2.02	3.75	2.41
Number of pauses		-	-	14.76	13.20	18.64	8.34
Pause duration (sec.)		-	-	6.85	4.74	18.88	9.77
Happiness	pre-film	6.65	0.89	6.24	1.15	6.67	1.31
	post-film	3.09	1.93	4.17	2.11	3.92	1.96
Anxiety	pre-film	1.57	1.47	1.66	1.52	1.38	1.81
	post-film	2.48	2.48	2.55	1.99	2.67	1.93
Horror	pre-film	0.30	0.64	0.59	0.98	0.33	0.57
	post-film	6.09	2.45	5.00	2.25	4.88	2.42
Depr. mood	pre-film	1.65	1.70	1.52	1.50	1.04	1.40
	post-film	4.57	2.27	3.83	2.51	3.42	2.04
Anger	pre-film	0.39	0.72	0.45	0.78	0.38	0.82
	post-film	4.43	2.91	3.62	2.71	4.67	2.75
STAI-S	pre-film	30.26	5.75	32.14	7.35	30.25	5.91
	post-film	39.43	8.94	39.31	12.37	43.42	9.53
Attention		9.09	0.73	5.97	2.24	8.71	1.20
Cued-recall		5.48	1.59	2.97	2.15	4.38	1.86
Recognition		5.78	1.31	5.17	1.34	5.63	1.21

** Corrected for demand characteristics*

Attention for the film. A one-way ANOVA with attention rating as the dependent variable and condition (control, verbal interference, verbal enhancement) as the between-participants factor was significant, $F(2, 73) = 30.55$, $p < .001$, $f = 0.92$. Post hoc analysis (Bonferroni correction) showed that attention rating was significantly lower in the verbal interference condition compared to the no-task control and the verbal enhancement condition, both $p < .001$. There was no significant difference between the latter two conditions, $p > .05$.

Memory for the film. A one-way ANOVA was performed with cued-recall as the dependent and condition as the independent variable, $F(2, 73) = 11.39$, $p < .001$, $f = 0.56$. Post hoc analyses (Bonferroni correction) showed a significantly lower performance in the verbal interference condition compared to the other two conditions, both $p < .05$. There was no significant difference between conditions with regard to recognition test performance, $F(2, 73) = 1.60$, $p = .21$.

Discussion

The main goal of this study was to investigate the role of peri-traumatic verbal processing in the development of intrusive memories. We aimed to replicate research (Holmes et al., 2004, Exp. 3) that grounded predictions in a dual-processing account of PTSD (e.g., Brewin et al., 1996). From this view predictions were (a) lower intrusion frequency with higher deliberate recall performance in the verbal enhancement condition compared to both the verbal interference and the no-task control condition; and (b) an increase in intrusion frequency with a decrease in deliberate recall in the verbal interference condition compared to the verbal enhancement and the no-task condition. Interestingly, we found lower intrusion frequency and deliberate recall (as well as attention rating) in the verbal interference condition compared to both other conditions. This pattern is in line with a general disruption of encoding of the film as predicted by mainstream models of attention and memory that do not assume separate memory systems for traumatic information (e.g., Baddeley & Hitch, 1994; Conway et al., 2004; Rubin, 2006).

Audio-recordings indicated that we taught participants to verbalise their emotions and thoughts instead of physical features of the film, thereby solving the problem that was reported in Holmes et al. (2004, Exp. 3). However, participants performed the task during only 20% of the film. It has been previously noted in the literature that enhancing processing style in participants is difficult. In addition to the problem reported in Holmes et al. (2004, Exp. 3), Halligan, Clark, and Ehlers (2002) also failed to have participants successfully apply data-driven or conceptual processing of an aversive film when this was not their natural processing style. We cannot rule out ‘‘silent processing’’ in our study but we suggest that low task performance is a more plausible interpretation of our results.

The finding that the verbal interference task reduced intrusion frequency as well as deliberate recall is in conflict with the DRT (Brewin et al., 1996). It is possible that counting backwards in 3s is not a purely verbal task as it involves more than verbalising numbers. However, the exact same task was used in Holmes et al. (2004, Exp. 3) and was defined as a verbal task there. Accepting a general cognitive load interpretation involving central executive resources would make their finding (an increase in intrusive memories in the verbal interference condition) problematic. A similar finding as ours was presented by Pearson, Sawyer, and Holmes (2008), and we echo their argumentation here. Several studies have shown that the central executive is involved in forming mental images from perceptual information in working memory and in keeping these images active (Pearson, 2001; Pearson, Logie, & Green, 1996; Rudkin, Pearson, & Logie, 2007). From this viewpoint, interfering with executive processes by a concurrent task disrupts the encoding of perceptual information.

A possible explanation for the incompatible findings of our study and the study by Holmes et al. (2004, Exp. 3) is a difference in the context given with the film material. The film clips in Holmes et al. were preceded by a short auditory introduction that informed participants about what had happened, the victims, and the outcome. In the present study and the studies by Pearson et al. (2008) participants were not given any introduction. It is possible that a film context affects verbal processing of the film because it may already activate conceptual processing. Also, our film material included different clips from those used in Holmes et al. (2004). Finally, participants in our study practised the counting backwards task before viewing, which is not reported in Holmes et al. (2004). Generally, the analogue trauma and healthy sample of limited size, common in trauma film studies, restrict generalisation to clinical populations. In this study we controlled for state and trait anxiety, but perhaps other moderators might be important as well (e.g., dissociation or schizotypy).

To conclude, our results do not support dual process accounts of PTSD (e.g., Brewin et al., 1996) with regard to the development of intrusive memories. Rather, our findings are in line with non-PTSD models of memory and attention (e.g., Conway & Pleydell-Pearce, 2000; Rubin, 2006) and indicate that analogue traumatic information is not encoded into separate memory systems (i.e., VAMs and SAMs). Our results contradict earlier findings (Holmes et al., 2004) and we believe that they should be inspirational for future research.

Chapter 5

Tell me more: Can a memory test reduce analogue traumatic intrusions?

This chapter is based on Krans, J., Näring, G., Holmes, E. A., & Becker, E. S. (2009). Tell me more: Can a memory test reduce analogue traumatic intrusions? *Behaviour Research and Therapy, 47*, 426-430.

Abstract

Information processing theories of post-traumatic stress disorder (PTSD) state that intrusive images emerge due to a lack of integration of perceptual trauma representations in autobiographical memory. To test this hypothesis experimentally, participants were shown an aversive film to elicit intrusive images. After viewing, they received a recognition test for just one part of the film. The test contained neutrally formulated items to rehearse information from the film. Participants reported intrusive images for the film in an intrusion diary during one week after viewing. In line with expectations, the number of intrusive images decreased only for the part of the film for which the recognition test was given. Furthermore, cued-recall memory after one week was selectively enhanced for the film part that was in the recognition test a week before. The findings provide new evidence supporting information processing models of PTSD and have potential implications for early interventions after trauma.

Introduction

Although several studies have investigated the role of peri-traumatic processing in intrusion development, post-trauma processing has received less attention. However, experimentally investigating post-trauma processing is important because it relates to current clinical practice where treatment starts after a traumatic event has occurred. The present study investigated whether intrusive images from viewing an aversive film can be reduced by giving a neutral, verbal recognition memory test immediately post-film aimed to help structure verbal memory.

Intrusive images can be defined as mental pictures (and other sensations) that come into consciousness unwanted and uncontrollably. Intrusive images are a common form of re-experiencing a traumatic event (Speckens, Ehlers, Hackmann, Ruths, & Clark, 2007) and are a core feature of post-traumatic stress disorder (PTSD; American Psychiatric Association, fourth edition, text revision, 2000). Recent information processing theories of PTSD (Brewin, Dalgleish, & Joseph, 1996; Ehlers & Clark, 2000) converge on the idea that intrusive images develop due to impaired information processing during the traumatic event (Holmes & Bourne, 2008). Normally, there is a balance between raw automatic encoding of mostly perceptual information and more conscious verbal conceptual information processing, leading to memory representations that incorporate perceptual features of an event within a conceptual framework. However, under extreme stress, the balance is thought to shift towards the more automatic and raw data processing (Holmes & Bourne, 2008), leading to memory representations with perceptual features but relatively lacking a conceptual framework. This prevents the representation from being integrated within autobiographical memory, making the image-based memory representation harder to recall deliberately and more prone to intrude into consciousness involuntary. Both models (i.e., Brewin et al., 1996 and Ehlers & Clark, 2000) build on existing theories of “normal” autobiographical memory (e.g., Conway, 1996; Conway & Pleydell-Pearce, 2000) to specify trauma-specific memory processes.

Several experimental studies support this information processing account of PTSD. For example, it has been found that blocking the visuospatial processing of an aversive film decreased subsequent intrusive images of the film (Brewin & Saunders, 2001; Holmes, Brewin, & Hennessy, 2004; Stuart, Holmes, & Brewin, 2006). Conversely, interfering with verbal processing during the encoding of an aversive film increased intrusive images (Holmes et al., 2004; but see Krans, Näring, & Becker, 2009). Furthermore, individuals with a preferred data-driven processing style developed more intrusive images from an aversive film compared to individuals with a conceptual processing style (Halligan, Clark & Ehlers, 2002). For a review, see Holmes and Bourne (2008).

Most studies have been on information processing *during* an aversive event with little experimental research investigating intrusion development *post*-event (Butler, Wells, & Dewick, 1995; Wells & Papageorgiou, 1995). Direct efforts to enhance conceptual post-event memory integration in order to reduce intrusive images have not been reported at the time of writing. Integrating a trauma representation in autobiographical memory is an important goal of effective cognitive-behavioural treatment for PTSD (Degun-Mather, 2001; Ehlers & Clark, 2000; Kindt, Buck, Arntz, & Soeter, 2007). The consideration of early interventions following a traumatic experience is of clinical relevance as well. Cognitive-behavioural treatment (CBT) appears to be effective in the aftermath of trauma (Sijbrandij et al., 2007). Currently, clinical practice guidelines advise to offer CBT no sooner than 1 month post-trauma and only in cases of severe posttraumatic stress symptoms or acute stress disorder (National Institute Clinical Excellence, 2003). Up to now, there are no recommended interventions within the first month post-trauma. However, information processing theories of PTSD (Brewin et al., 1996; Ehlers & Clark, 2000) suggest that interventions aimed at enhancing memory integration should be helpful in preventing intrusion development.

In sum, the role of post-event information processing in intrusion development has been neglected in experimental studies despite clear theoretical and clinical relevance. The present study aimed to experimentally explore the effect of enhancing memory integration on the development of intrusive images. To induce intrusive images, participants viewed an aversive film with traumatic content. We aimed to enhance memory integration by administering a verbal recognition memory test for one part of the film directly after viewing. The items on the recognition memory test were in chronological order, thereby allowing participants to think through the film in a structured and detailed way. The recognition memory test was thus used as an experimental intervention, rather than an actual memory test per se. Although the items were statements about emotional events from the film, the wording of the statements was neutral. By administering the recognition memory test, information of the trauma film is rehearsed in a structured way. This should enhance the formation of verbally accessible and organized memories that can be retrieved deliberately and theoretically reduce intrusive images. We hypothesized that participants would show fewer intrusive images of the film after one week for that part of the film for which they received the memory test, in contrast to the part of the film for which they did not receive the memory test. In addition, we hypothesized that participants' performance on the memory test would selectively strengthen memory for that part of the film one week later.

Method

Overview

After screening for exclusion criteria (described below), participants viewed the aversive film. The film consisted of two parts, which were shown in counterbalanced order. After the film, participants completed the recognition memory test for one part of the film according to random allocation. Questionnaires were administered at baseline and post-film. In the week following film viewing, participants reported their intrusions of the film in a diary. After one week, participants returned for a follow-up session.

Participants

All participants were psychology students in their first semester. They received course credit for participation. As required by the ethical committee (CMO approval number 2005/063), participants were informed about the graphic content of the film beforehand (as in previous studies by Holmes et al., 2004). Exclusion criteria were: panic attacks, panic disorder, PTSD, major depressive episode (current and lifetime), social phobia, and psychotic episode (current and lifetime), blood phobia, history of fainting and significant experience with road traffic accidents (RTA). Two participants terminated film viewing and did not complete the experiment. Total data from 57 participants was collected. Gender and age was equally distributed across the conditions (all p > .05). Table 1 displays the number of participants in every condition.

Table 1. *Number of participants for each combination of film version and recognition memory test version*

	Memory test version A	*Memory test version B*
Film version AB	13	13
Film version BA	15	11

Materials

Aversive film. The aversive film from Hagenaars, van Minnen, Holmes, Brewin and Hoogduin (2008), originally compiled by Steil (1996), was used. It contains four scenes showing the aftermath of real-life RTAs and has previously been shown to induce intrusive images (e.g., Holmes et al., 2004). Following the method of Stuart et al. (2006), the film was divided into two parts (or 'blocks') that were matched for the number of intrusive images they were likely to produce based on data from a pilot study with student participants, see Table 2. Matching for number of intrusive images instead of time of the film scenes was done to create a comparable "baseline" number of intrusions for both film blocks; with "baseline" being the number of intrusions had there not be any intervention at all. Accordingly, the film was divided in scenes 1 – 3 (Block A; 8 minutes and 53 seconds) and scene 4 (Block B; 2 minutes and 45 seconds). The film blocks were presented in counterbalanced order (AB or BA). The film was projected onto a smooth white wall and sound was presented through headphones.

Table 2. *Number of intrusive images from each scene of the aversive film in the pilot study*

	Part A			*Part B*
	Scene 1	*Scene 2*	*Scene 3*	*Scene 4*
Intrusive images	34	20	30	85

Memory integration. The recognition memory test used to enhance memory integration was similar to the recognition memory test used in the 1-week follow-up session of previous studies (e.g. Holmes et al., 2004). It contained statements (for example, "There were three doctors in white coats present at the scene") for which participants had to decide whether it was true or false. The items were in chronological order and the statements, although emotional in content, were neutral in formulation. To match the film blocks, there were two versions of the test: Version A (Film block A) and version B (Film block B).

Measures

Emotional impact of the film. This was measured with a mood questionnaire (Holmes et al., 2004). On a 0-10 point scale (0 = not at all, 10 = extremely), participants rated current happiness, fear, horror, depressed mood and anger. In addition, the Dutch version of the State-Trait Anxiety Inventory (Zelfbeoordelingsvragenlijst; Van der Ploeg, 1980) was used to assess state anxiety (STAI-S). This questionnaire contains 20 items about the current level of anxiety, with ratings from 1 (almost never) to 4 (almost always) and is reported to have a good reliability and validity (Van der Ploeg, 1980).

Intrusive images. The intrusion diary was similar to the one in Holmes et al. (2004). Participants were given thorough instructions as to how to complete the daily diary and reported their intrusions of the film during the week after film viewing. The diary contained a definition of intrusive images and reminder instructions on how to keep the diary. Participants reported the content of each intrusion so it could be assigned to a specific film scene. Additionally, participants rated the distress of every intrusion on a scale from 0 (not at all distressing) to 100 (extremely distressing). To enhance compliance, participants were required to hand in one page of the diary every day.

Deliberate recall. At one week follow-up, participants filled in a cued-recall memory test (Holmes et al., 2004) about the whole film. This contained two to four questions per scene and 12 items in total (for example: "Which body parts were wounded and bleeding when the woman was freed from the minivan and was lying down on the stretcher?").

Attention for the film. After the film, participants rated the attention they paid to the film on an 11-point scale (0 = not at all focused on the film, 10 = completely focused on the film).

Diary compliance. At follow-up, participants rated how often they thought they forgot to write down their intrusions, on a scale from 0 (never forgot to write down the intrusion) to 10 (always forgot to write down the intrusion) as in Holmes et al. (2004).

Demand characteristics. At follow-up, participants were asked about the goal of the study with an open-ended question.

Procedure

Participants filled in a demographic questionnaire, the mood ratings and the STAI-S and then viewed the aversive film. Participants were instructed to stay focused on the film, not to look away or mentally disengage and to view the film as if they were really there at the scene. They were informed that they could terminate the experiment at any time. Film version (AB or BA) was randomly assigned, with the restriction that an equal number of participants viewed each version. Immediately after the film ended, the recognition test was given. The version of the recognition test (A or B) was randomly assigned to participants, with the restriction that half of the participants who viewed either film version received test version A and the other half test version B (see Table 2). Participants then filled in the mood questionnaire, the STAI-S and the attention rating. During the week after film viewing, participants reported their intrusions of the film in the diary. At follow-up, they filled in the diary compliance rating, the cued-recall memory test and were asked about the perceived goal of the study.

Results

Outliers and compliance

Four participants failed to complete the intrusion diary and were deleted from the dataset. Data of the number of intrusions was checked for outliers (more than three standard deviations from the mean) per condition (with recognition test versus without recognition test) using boxplots. One multivariate outlier was deleted from the dataset. Six univariate outliers were changed into the next extreme score minus one since the outliers were above the mean (Tabachnick & Fidell, 1996). The final dataset contained 52 participants (37 women and 15 men), with an average age of 19 years and 10 months (SD = 3 years and 6 months).

Control measures

Emotional impact. Repeated measures ANOVAs were conducted for all emotion variables. There was a significant decrease from pre-film to post-film for happiness, $F(1, 51)$

$= 13.33$, $MSE = 1.59$, $p < .01$, $\eta^2 = .21$. There was a significant increase in horror, $F(1, 51) = 34.20$, $MSE = 1.76$, $p < .01$, $\eta^2 = .40$; depressed mood, $F(1, 51) = 14.15$, $MSE = 1.57$, $p < .01$, $\eta^2 = .22$; and state anxiety STAI-S, $F(1, 51) = 18.07$, $MSE = 23.47$, $p < .01$, $\eta^2 = .26$, but not in the single item anxiety rating, $F < 1$, or anger from the mood questionnaire, $F(1, 51) = 2.17$, $MSE = 0.54$, $p = .15$.

Attention for the film. The overall attention rating for the film was $M = 8.27$, $SD = 1.83$.

Diary compliance. The average diary compliance rating was $M = 1.98$, $SD = 1.11$, indicating a high level of compliance.

Experimental measures

Intrusion frequency. To test the effect of the memory test on the number of intrusive images, we performed a 2 (Task: recognition memory test versus no recognition memory test) x 2 (Memory test version: A or B) x 2 (Film version: AB or BA) mixed model ANOVA with Test version and Film version as a between-subject factors and Task as a within-subjects factor. The results showed a significant effect of Task on the number of intrusive images, $F(1, 48) = 5.67$, $MSE = 0.52$, $p = .02$, partial $\eta^2 = .11$. There was no significant effect of Test version, $F < 1$, or Film version, $F(1, 48) = 1.97$, $MSE = 1.14$, $p = .17$ and there were no interaction effects. As predicted, participants reported fewer intrusive images from scenes for which they had received the recognition memory test, $M = 0.46$, $SD = 0.73$, compared to scenes for which they had not received the recognition memory test, $M = 0.79$, $SD = 1.06$.

Intrusion distress. Table 3 presents the descriptive statistics for the summed and average distress ratings for the film block for which participants received a memory test and for the film block for which they received no test. Only participants who reported intrusions ($n = 44$) are included. Three univariate outliers were adjusted (Tabachnick & Fidell, 1996). To investigate whether the memory test affected intrusion distress, we performed two 2 (Task: recognition memory test versus no recognition memory test) x 2 (Memory test version: A or B) x 2 (Film version: AB or BA) mixed model ANOVAs with Test version and Film version as a between-subject factors and Task as a within-subjects factor on both summed and average distress scores. The results show no significant main effect or interaction effects for the summed distress scores (all $p > .05$), although there was a trend for a main effect of Task,

$F(1, 40) = 3.09$, $MSE = 3758.60$, $p = .087$, partial $\eta^2 = .07$. There were no significant main effects or interactions for the average intrusion distress ratings (all $p > .05$).

Table 3. *Descriptive statistics of the summed and average intrusion distress ratings for the tested and non-tested film block*

Measure	*Film block without memory test* *M (SD)* *Range*	*Film block with memory test* *M (SD)* *Range*
Summed distress	74.58 (103.91) 0 - 350	51.53 (75.50) 0 - 270
Average distress	19.29 (21.89) 0 - 70	15.69 (19.14) 0 - 60

Deliberate recall. The mean score on the cued-recall test at follow-up was $M = 6.85$, $SD = 1.68$. To check if the reduction was likely to be because of a more integrated memory for the film, we performed a one-way ANOVA with Test version (A, B) as the independent variable and cued-recall memory test performance at follow-up for scenes 1-3 (Film block A) as the dependent variable. This revealed significantly higher performance for participants who received the recognition memory test for scenes 1-3, $M = 5.68$ and $SD = 1.19$, than those who had received the test for scene 4, $M = 3.58$ and $SD = 0.97$, $F(1, 50) = 47.32$, MSE = 1.20, $p < .01$, $\eta^2 = .49$. An independent sample *t*-test indicated that participants who received the memory test for scene 4 (Film block B) performed significantly better on the cued-recall memory test for that scene at follow-up, $M = 2.54$, $SD = 0.72$, than participants who received the memory test for scenes 1-3, $M = 1.79$, $SD = 1.10$, corrected $t(46.98) = - 2.97$, $p = .01$, $d = .82$.

Demand characteristics. None of the participants mentioned modulation of intrusive images when asked for the goal of the study.

Discussion

The critical finding was that the recognition memory test administered immediately post-film selectively decreased the number of intrusive images, in line with our hypothesis. In addition, intrusive images from the film block for which participants received the memory test tended to have lower distress ratings than for the film block for which participants did not receive a memory test, although this finding did not reach significance. Furthermore, the recognition memory test selectively increased performance on the cued-recall memory test at one week follow-up. We propose that by performing this recognition memory test immediately after an aversive film, the film's representations in memory become more integrated (i.e. not fragmented and isolated) with autobiographical memory, as measured by improved deliberate recall performance. The findings are in line with information processing accounts of PTSD (Brewin et al., 1996; Ehlers & Clark, 2000) suggesting that a trauma-memory representation becomes intrusive because it is fragmented and isolated from autobiographical memory. As to what the exact processes are that underlie the reduction in intrusive images and the enhanced deliberate recall performance, it seems likely that a reduction of avoidance facilitated by the recognition memory test played a role.

The present study showed that a rather simple intervention – a structured, verbal recognition memory test – was effective in reducing one aspect of post-traumatic stress symptoms: intrusive images. The memory test contained factual information about the film, not specifically about the emotional parts, and provided a rehearsal opportunity. We suggest that this may have strengthened the conceptual memory for the film, reducing intrusions. Future research should explore the exact cognitive mechanisms underlying memory integration. For example, it is possible that by presenting the memory test avoidance reduces, resulting in fewer intrusions. Another interesting question is whether active engagement is necessary or if passively reading information of an aversive event is sufficient for a reduction in intrusive images.

There are some general limitations to our study. First, generalization of our findings to actual trauma survivors is not warranted, since our study reported on a non-clinical sample exposed to an analogue traumatic situation (an aversive film). Further, the number of intrusive images was measured during only one week after film viewing. The general tendency was that participants did not experience any more intrusive images after this week. This may not reflect the actual time curve for non-analogue traumatic intrusions and more research is needed with prolonged follow-up measures.

To conclude, the finding that a recognition memory test reduces intrusive images from an aversive film is relevant for both theory and practice. The results of our study are encouraging for research moving beyond the debate related to the lack of successful early trauma interventions, such as critical incidence stress debriefing (e.g. Bisson et al., 1997; Mayou et al., 2000: Sijbrandij et al., 2007). That is, it may point to new target possibilities for developing evidence-based early crisis interventions for traumatic events. Our findings are supportive of the cognitive model of PTSD (Ehlers & Clark, 2000) and the dual representation theory (Brewin et al., 1996; Brewin, 2001). Both models suggest that intrusive images develop as a result of impaired peri-traumatic information processing, leading to isolated image-based representations that relatively lack a verbal conceptual embedding. Promoting verbal processing with a recognition memory test both reduced the frequency of intrusion images and enhanced deliberate recall, as would be predicted by these models. The findings from the current study encourage future research exploring the nature and role of memory integration immediately post-trauma in intrusion development. Our findings have potential clinical relevance since they indicate it may be possible that interventions aimed at structuring and enhancing memory integration for an aversive event could be used to reduce intrusion-development.

Chapter 6

"I see what you're saying": Intrusive images from listening to a traumatic verbal report

This chapter is based on Krans, J., Näring, G., Holmes, E. A., & Becker, E. S. (2009). "I see what you're saying": Intrusive images from listening to a traumatic verbal report. *Journal of Anxiety Disorders, 24*, 134-140.

Abstract

We tested the hypothesis that intrusive visual images could develop from listening to a traumatic verbal report. Eighty-six participants listened to a traumatic verbal report under one of three conditions: while shaping plasticine (visuospatial condition), while performing articulatory suppression (verbal condition), or with no extra task (control condition). Results showed that intrusive visual images developed from listening to the traumatic report. In line with the idea that central executive processes guide encoding of information, intrusion frequency was reduced in both the visuospatial and the verbal condition compared to the no task control condition. Overall, this pattern is similar to intrusive images from a traumatic film as found in earlier studies. This study provides a valuable addition to models of post-traumatic stress disorder and autobiographical memory. Additionally, the results have potential implications for therapists working with traumatized individuals.

Introduction

The experience of a traumatic event can lead to development of intrusive memories: uncontrollable and distressing images of the traumatic event that repeatedly come into consciousness unbidden, such as the sights and sounds of a terrifying car crash (Grey & Holmes, 2008). Intrusive memories in post-traumatic stress disorder (PTSD) are mostly visual in nature, although images from other senses and verbal intrusions are also reported (Speckens, Ehlers, Hackmann, Ruths, & Clark, 2007). The content of intrusive images, however, is not necessarily restricted to actual memories or even the diagnosis of PTSD (Hackmann & Holmes, 2004). Intrusive images can also display fantasies of alternative outcomes, future events (flash-forwards; Holmes, Crane, Fennell, & Williams, 2007), or reflect a story told by another (Pearlman & Mac Ian, 1995; McCann & Pearlman, 1990; Figley, 1995). In the last two decades it has been acknowledged that learning about a traumatic event without being personally involved (i.e., secondary traumatisation) can induce post-traumatic stress symptoms. In a classic paper, Terr et al. (1999) found that children who heard about the explosion of the *Challenger* space shuttle in 1986 afterwards developed post-traumatic stress symptoms, such as nightmares, *Challenger*-specific fears and negative expectations of the future. Furthermore, it has been shown that therapists and other helpers are at risk of developing intrusive images of their client's traumatic experience (Pearlman & Mac Ian, 1995; McCann & Pearlman, 1990; Figley, 1995). Secondary traumatic stress in people dealing with trauma survivors has been distinguished from burnout and seems to be specifically related to treating trauma survivors (McCann & Pearlman, 1990; Arvay 2001).

Studies have mainly used survey methods to explore broad clusters of secondary stress symptoms (Arvay, 2001). Although these studies give important information on secondary stress, they lack the benefits of an experimental design and are too broad in focus to assess basic processes underlying specific symptoms like intrusive images or how these might arise.

The goal of our study was to investigate whether intrusive *visual* images could develop from *verbal* information by evoking mental imagery when listening to traumatic material. That is, whether people would develop flashback-like images to a trauma they had never seen, but only imagined. Furthermore, we explored whether the frequency of these "imagined" intrusions could be modulated by interfering with the encoding of analogue traumatic information.

Two influential models that aim to explain intrusion development in PTSD are the dual representation theory (Brewin, Dalgleish, & Joseph, 1996) and the cognitive model of PTSD by Ehlers and Clark (2000). According to a pragmatic model by Holmes and Bourne (2008), these models converge on the idea that the balance between peri-traumatic visuospatial and verbal processing predicts intrusion development. During high stress, information processing shifts in favour of visuospatial processing with a relative lack of verbal conceptual processing. Resulting memory representations are rich in sensory detail but are not conceptually integrated within autobiographical memory (Holmes & Bourne, 2008). Accordingly, interference of visuospatial processing during encoding should reduce intrusion development whereas interference of verbal processing should increase intrusion development.

Alternatively, the self-memory-system (SMS) model (Conway & Pleydell-Pearce, 2000; Conway, Singer, & Tagini, 2004) is a more general model of autobiographical memory that, importantly, also aims to explain intrusive memories. The "working self" consists of active goals and serves to allocate attention and motivates behaviour in the broadest sense. The working self guides encoding of information through control processes such as the central executive in working memory. As with more "ordinary" events, episodic memories with highly sensory detail are initially formed of the traumatic event. In contrast to non-traumatic memories, the episodic trauma memories are not easily integrated within the autobiographical knowledge base and thus direct activation of trauma memories by internal or external cues can therefore not be inhibited and intrusive images persist (Conway & Pleydell-Pearce, 2000; Conway et al., 2004). One hypothesis that can be derived from the SMS model is that interfering with central executive capacity during encoding should reduce intrusion development regardless of the modality of the interference (i.e., visuospatial, verbal) because less traumatic information is encoded.

Generally speaking, there are two views on intrusion development: PTSD-specific models propose modality-specific effects of encoding interference in relation to intrusion development, whereas more general autobiographical models suggest that modulation of intrusive memories is dependent on the encoding capacity guided by the central executive. While the PTSD-specific view provides an often used framework for research on intrusion development, more general models of autobiographical memory, like the SMS model, have been less associated with the subject of intrusion development.

Many studies testing hypotheses from information processing models of PTSD have adopted the trauma film paradigm (Holmes & Bourne, 2008). Typically, healthy participants view an aversive film while performing a concurrent task that relies on visuospatial or verbal resources. During the week after film viewing, participants report their intrusive images in a diary. A general finding is that performing a visuospatial task during encoding of an aversive film reduces intrusion development compared to a no task control condition or other movement condition (e.g., Brewin & Saunders, 2001; Holmes et al., 2004; Stuart, Holmes, & Brewin, 2006; Krans, Näring, Holmes, & Becker, 2010). This finding has been extended to a visuospatial task given in the post-film period (Holmes, James, Coode-Bate, & Deeprose, 2009). Verbal processing has been studied to a lesser extent, and results are more mixed. Some studies (e.g., Holmes et al., 2004; Bourne, Frasquilho, Roth, & Holmes, submitted) have found an *increase* in intrusion frequency from verbal interference, as would be predicted from dual process models (Holmes & Bourne, 2008). In contrast, others have found a *decrease* in intrusion frequency as a result of verbal interference (e.g., Krans, Näring, & Becker, 2009; Pearson, Sawyer, & Holmes, 2008), which is in line with the SMS model (Conway & Pleydell-Pearce, 2000; Conway et al., 2004).

Clinical models of PTSD (Brewin & Holmes, 2003) focus on intrusive memories from direct sensory experience. However, stressful intrusive images can also develop from listening to an aversive story, as studies of secondary traumatic stress have shown (Pearlman & Mac Ian, 1995; McCann & Pearlman, 1990; Figley, 1995). Because listening to trauma narratives is an important part of a therapist's job in effective cognitive behavioural treatment (National Institute for Health and Clinical Excellence, 2005), more knowledge about how to modulate this kind of intrusion may aid in preventing intrusion development in clinicians, and thus also to therapist "burn out".

The main goal of our study was to investigate the development of intrusive *visual* images as a result of *verbal* input. As a variation to the trauma film paradigm, we presented participants with an aversive verbal report of a traumatic situation and asked them to imagine the story. Our main research questions were: (a) to ascertain whether intrusive images would develop from a verbal report and (b), if so, could their frequency be modulated by interfering with encoding of the provoking verbal stimulus? We predicted (1) that intrusive images would develop, and (2) that visuospatial interference during encoding would reduce intrusion development compared to no extra task. Verbal interference was added as a concurrent-task control condition. An increase in intrusive images in this verbal condition compared to no-task would be in line with dual-process models of PTSD (Brewin et al., 1996; Ehlers & Clark, 2000) as suggested by Holmes and Bourne (2008), whereas a reduction would be in line with a hierarchical model of autobiographical memory such as the SMS model (Conway & Pleydell-Pearce, 2000). To control for individual differences that could be related to intrusion development, we assessed spontaneous use of imagery, trait dissociation, and trait anxiety.

Method

Questionnaires and instructions were presented on a PC using Perseus® Software (Version 6).

Participants

Participants were invited by e-mail to participate in exchange for course credit. As required by the ethical committee (CMO approval number 2005/063), the invitation contained information about the graphic nature of the film/report. In total, 90 participants completed the study. Exclusion criteria were: panic attacks, panic disorder (current and lifetime), PTSD (current and lifetime), major depressive episode (current and lifetime), psychotic episode (current and lifetime), blood phobia, history of fainting, and history of road traffic accidents. Four participants failed to complete the intrusion diary and were excluded from the dataset. The final dataset contained 60 women and 26 men with an age of $M = 22.01$ years ($SD = 3.14$). Seventy participants were students, and 16 participants were either working or seeking employment. The non-student participants were comparable on age, $F(2, 83) = 0.42$, $p = .66$, and trait imagery, $F(2, 83) = 0.08$, $p = .92$, but showed higher levels of trait dissociation, $F(2,82) = 4.07$, $f = 0.33$, $p = .02$; and trait anxiety, $F(2, 82) = 4.71$, $f = 0.34$, $p = .01$, compared to the student participants. Running the analyses in the student sample only yielded the same result pattern; since level of education was equally distributed between the three conditions, $\chi^2(4) = 4.17$, $p = .38$, the non-student participants were included in the analyses reported below.

Materials

*Verbal report. T*he verbal report (11 min 42 sec) was based on an often used 'trauma film' depicting the aftermath of real-life road traffic accidents (Steil, 1996) for studying the development of traumatic intrusions (Holmes & Bourne, 2008). The cover story was that a traffic journalist was describing the events into a voice-key for later use. The background noise of the original film was audible in the recording. Each scene was preceded with a short auditory introduction about the people involved in the accident and the outcome. Participants listened to the report through headphones.

Experimental task. All participants were instructed to focus on the report while imagining everything that the journalist described using field perspective, that is, as if looking through one's own eyes (Holmes, Coughtrey, & Connor, 2008). In the visuospatial interference condition, participants shaped plasticine into small cubes and pyramids alternately as fast and accurate as possible (Stuart et al., 2006). Hands were covered with a wooden inverse U-shaped box. In the practice trial, participants were shown an example of each plasticine figure and were asked to copy this. In the verbal interference condition, participants counted from 1 to 6 continuously at a speed of three digits per second (Larsen & Baddeley, 2003). They were instructed to whisper so that utterances could be recorded but did not interfere with listening to the traumatic report. In the practice trial, participants performed the task paced by a metronome for one minute. Imagery of the report (vividness and distress) was rated on a 4 – point scale (1 = totally disagree, 4 = totally agree).

Control measures

Individual differences. Trait imagery was measured with the Spontaneous Use of Imagery Scale (SUIS). The SUIS has high internal consistency with $\alpha = .98$ and has a significant relationship with other imagery measures (i.e., VVIQ; Marks, 1973) supporting its validity (Reisberg, Pearson, & Kosslyn, 2003). The scale contains 12 items that are rated on a 1-5 point scale (1 = never appropriate, 5 = completely appropriate). Trait dissociation was measured with the Dissociative Experiences Scale, revised (DES-II; Bernstein & Putnam, 1986). The DES-II contains 28 items and answers are rated on an 11-point scale from 0 % (never) to 100 % (always). The DES-II has a test-retest reliability of .84 and a median coefficient for construct validity of .64 (Bernstein & Putnam). Trait anxiety was measured with the Dutch version of the State-Trait Anxiety Inventory (STAI-T; Van der Ploeg, 1980). The STAI-T contains 20 items about general anxiety level, with ratings from 1 (almost never) to 4 (almost always). The STAI-T showed a test-retest reliability of .75 and an internal consistency of $\alpha = .85$ (Van der Ploeg, 1980).

Impact of the report. A mood questionnaire (Holmes et al., 2004) measured current happiness, fear, horror, depressed mood, and anger on an 11-point scale (0 = not at all, 10 = extremely). The state version of the State-Trait Anxiety Inventory was used to assess state anxiety (STAI-S; Van der Ploeg, 1980). This questionnaire contains 20 items about current anxiety level, with ratings from 1 (almost never) to 4 (almost always). Test-retest reliability has been reported at .25 and up, and the internal consistency at $\alpha = .88$. State dissociation was measured with the self-report version of the Dissociative States Scale (DSS; Bremner et al., 1998). The questionnaire contains 19 items and answers are rated on a 5-point scale from 0 (not at all) to 4 (very much). Reliability has been shown at $\alpha = .94$. The DSS discriminates between PTSD patients and non-patients, supporting its validity (Bremner et al., 1998).

Experimental measures

Intrusion frequency. Intrusive images were reported in an event-related diary (Holmes et al., 2004). For every entry, participants reported intrusion frequency, nature (sensory or verbal), and content. An intrusion provocation task (Lang, Holmes, & Moulds, 2009) was included as an alternative measure of intrusion frequency. Participants were presented with ten 4-second neutral fragments from the report and then were required to think freely for two minutes while pressing a key whenever an intrusion occurred.

The Impact of Event Scale (IES; Horowitz, Wilner, & Alvarez, 1979; Dutch version by TZP Psychotrauma, 2006) contains an Intrusion subscale (8 items), an Avoidance subscale (8 items) and a Hyperarousal subscale (6 items). Answers are rated on a 5-point scale from 0 (not at all) to 4 (very much). Internal consistency has been reported at 0.97 for the Total score, 0.86 for the Intrusion subscale, 0.82 for Avoidance, and 0.85 for Hyperarousal. Test-retest reliability has been reported at 0.87 for the Total score, 0.89 for the Intrusion scale, 0.79 for Avoidance, and 0.82 for Hyperarousal (Sundin & Horowitz, 2002).

Other PTSD symptoms. Avoidance was measured with the avoidance subscale of the IES (Horowitz et al., 1979) and with a single-item on an 11-point scale (0 = not at all, 10 =

very strongly). Participants rated the fragmentation of their memory of the report on an 11-point scale (0 = not at all, 10 = very strongly).

Post-traumatic cognitions in relation to the report were measured with the Post-traumatic Cognitions Inventory (PTCI; Foa, Ehlers, Clark, Tolin, & Orsillo, 1999; Dutch version by van Minnen, 2001). The PTCI consists of three subscales: Negative cognitions about self (21 items), Negative cognitions about the world (7 items) and Self-blame (5 items). Statements are rated on a 7-point scale from 1 (totally disagree) to 7 (totally agree). Internal consistency has been reported at α = .97 for the Self scale, .88 for World, and .86 for Self blame. Test-retest reliability has been reported at .75 and higher (Foa et al., 1999).

Attention and memory. Attention for the report was rated on an 11-point scale from 0 (not at all) to 10 (completely). Cued-recall memory was assessed with 12 open ended questions about the journalist report. Recognition memory was assessed with 12 statements of the report with a yes/no response.

Compliance and demand. Participants rated the appropriateness of the statement “I have often been unable (or have forgotten) to report my intrusions in the diary” on an 11-point scale from 0 (not at all) to 10 (very much), as in Holmes et al. (2004). Participants were asked about the perceived goal of the study with an open-ended question. In the visuospatial and verbal interference conditions participants indicated if they thought their task had increased, decreased or had no effect on intrusion frequency.

Procedure

Participants signed an informed consent and filled in the SUIS, STAI-T, DES-II, STAI-S, DSS, and the mood questionnaire. All participants received short imagery training in field perspective (Holmes et al., 2008). Participants were instructed according to experimental condition and the recording of the journalist report was started. After the report, participants filled in the imagery compliance check, the mood questionnaire, STAI-S, DSS, the attention rating, and received the diary. After one week, participants returned for follow-up. The intrusion provocation task was performed and participants filled in the diary compliance rating, cognitive avoidance item, cued-recall and recognition memory test, the IES, PTCI, and ratings about the perceived goal of the study. Finally, participants were debriefed and thanked for their involvement.

Statistical approach

Analysis of variance (ANOVA) was the main statistical method used. In cases where Levene's statistic was significant (indicating a violation of the homogeneity of variance) corrected t-tests or non-parametric tests are reported. A priori hypotheses were tested directionally. Spearman correlations were calculated for intrusion frequency because of non-normal distribution. An α of 0.05 was regarded as the level of significance. Effect sizes reported are Cohen's *d* for t-tests and Cohen's *f* for ANOVAs. Descriptive statistics are presented in Table 1 and 2.

Results

Compliance, demand, and outliers

The mean diary compliance rating was M = 1.56 (SD = 1.50), indicating high compliance. Participants in the verbal interference condition repeated the "123456" string M = 291.80 times (SD = 46.13), with M = 9.30 errors (SD = 7.15) and M = 2.70 pauses (SD = 2.47). In the visuospatial interference condition, participants produced M = 20.33 plasticine objects (SD = 5.22). Eighteen participants mentioned intrusion modulation as the goal of the experiment but there was no difference in intrusion frequency compared to those who did not ($p > .05$).

All variables were checked on multivariate and univariate outliers across and within conditions as advised by Tabachnick and Fidell (1996). One multivariate outlier was identified and removed from the dataset. Nine univariate outliers were detected and were adjusted appropriately. Unfortunately, the IES-hyperarousal scale yielded many univariate outliers and it was decided to exclude this scale from analyses (Tabachnick & Fidell, 1996).

Control measures

Randomization check. One-way ANOVAs with condition (control, visuospatial interference, verbal interference) as the between-subject factor indicated no significant difference between conditions in trait imagery, $F(2, 83) = 1.08$, $p = .35$, or trait anxiety (STAI-T), $F(2, 83) = 0.21$, $p = .81$. A Kruskal-Wallis test with condition (control, visuospatial interference, verbal interference) as the between-subject factor and indicated no significant difference in trait dissociation (DES-II) between the three conditions, $\chi^2(2) = 5.11$, $p = .08$.

Manipulation check. The ratings on the mood questionnaire were summed into a single score (happiness reversed; Mackintosh et al., submitted). A 3 condition (control, visuospatial interference, verbal interference) x 2 mood (pre-report, post-report) mixed model ANOVA with condition as the between-subject factor and mood ratings as the within-subject factor showed a significant increase in negative mood from pre- to post-report, $F(1, 83) = 30.56$, $f = 0.61$, $p < .001$. There was no significant main effect of condition or a significant interaction (both $p > .05$). The same pattern emerged for state anxiety (STAI-S), with a significant increase pre- to post report, $F(1, 83) = 40.59$, $f = 0.70$, $p < .001$.

A 3 condition (control, visuospatial interference, verbal interference) x 2 DSS (pre-report, post-report) mixed model ANOVA was performed with condition as the between-subject factor and state dissociation (DSS) as the within-subject factor. There was no significant main effect (both $p > .05$) but a significant condition x DSS interaction emerged, $F(2, 83) = 3.09$, $f = 0.27$, $p = .05$. Repeated measures ANOVAs within conditions with state dissociation (DSS) as the within-subject factor indicated that there was a significant *decrease* in state dissociation in the visuospatial interference condition, $F(1, 26) = 6.03$, $f = 0.48$, $p = .02$, but no significant change in the control or the verbal interference condition (both $p > .05$).

Table 1. *Means and standard deviations of control measures within and across conditions*

		Control condition		*Visuospatial interference*		*Verbal interference*		*Total*	
Measure		*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
SUIS		40.11	6.23	38.26	7.31	37.81	5.32	38.70	6.30
STAI-T		36.32	8.13	36.81	8.26	35.42	8.69	36.15	8.30
DES-II		9.99	7.09	14.06	9.67	8.49	6.06	10.73	7.95
Mood Q	Pre	7.43	3.67	7.89	5.92	8.16	5.68	7.84	5.15
	Post	11.39	5.55	11.26	7.43	11.71	7.49	11.47	6.82
STAI-S	Pre	32.50	7.10	33.59	8.28	33.45	8.56	33.19	7.94
	Post	37.07	8.64	37.11	8.20	40.19	6.40	38.21	7.81
DSS	Pre	1.86	2.81	2.33	2.04	2.19	2.52	2.13	2.46
	Post	2.32	3.17	1.63	1.69	3.00	2.91	2.35	2.72

Experimental measures

Intrusion frequency. The à priori hypotheses were tested with directional tests. As predicted, the number of intrusive images reported in the diary was lower in the visuospatial condition than in the no task control condition, $t(53) = 2.53$, $d = 0.71$, $p < .001$ (one-tailed). Intrusion frequency was also lower in the verbal interference condition compared to no task, $t(57) = 2.51$, $d = 0.66$, $p = .02$ (two-tailed). There was no significant difference between the visuospatial and the verbal interference condition, $t(56) = 0.06$, $p = .96$ (two-tailed).

The same pattern emerged for intrusions in the provocation task. Intrusion frequency was significantly lower in the visuospatial interference condition compared to the no-task control condition, corrected $t(39.74) = 2.83$, $d = 0.80$, $p < .01$ (one-tailed), but not significantly different from the verbal interference condition, $t(56) = 1.44$, $p = .15$ (two-tailed). Intrusion frequency was not significantly different in the verbal interference condition compared to the no-task control condition, corrected $t(45.05) = 1.72$, $p = .09$ (two-tailed), although the direction was similar to the diary measure.

Both the intrusion diary and the provocation task were significantly correlated with the IES-intrusion scale, and with each other, as reported in Table 3.

Other PTSD symptoms. One-way ANOVAs with condition (control, visuospatial interference, verbal interference) as the between subject factor showed no significant differences between conditions on the avoidance single-item, IES-avoidance subscale, fragmentation rating, or the PTCI subscales, all $p > .05$. Correlation coefficients are reported in Table 3.

Intrusion frequency in the diary was significantly related to the IES-intrusion scale, single-item measure of avoidance, the IES-avoidance scale, and the PTCI-self blame scale. The diary measure was not significantly related to the other PTCI scales or the fragmentation rating, all $p > .05$. Intrusion frequency in the provocation task was significantly related to the IES-intrusion scale, the single-item measure of avoidance and the fragmentation rating, but not with the IES-avoidance scale or the PTCI scales, all $p > .05$. Furthermore, there was a significant correlation between the single-item measure of avoidance and the IES-avoidance scale.

Table 2. *Means and standard deviations of experimental measures within and across conditions*

	Control condition		*Visuospatial interference*		*Verbal interference*		*Total*	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Number of intrusive images in diary	4.57	3.69	2.48	2.23	2.52	2.55	3.17	3.01
Number of intrusive images in provocation task	3.54	2.94	1.78	1.45	2.42	1.88	2.58	2.27
IES – intrusion	5.11	2.53	3.70	3.58	4.16	3.23	4.33	3.16
IES – avoidance	4.07	2.18	2.81	2.88	3.65	3.28	3.52	2.85
Single-item avoidance	1.57	2.04	0.78	0.97	1.52	2.05	1.30	1.80
Fragmentation	6.11	2.77	6.30	2.96	5.77	2.62	6.05	2.75
PTCI – negative cognitions about self	1.64	0.51	1.62	0.64	1.54	0.55	1.60	0.56
PTCI – negative cognitions about the world	2.94	1.09	2.68	1.20	2.62	1.33	2.74	1.21
PTCI – self blame	1.98	0.76	1.86	0.74	1.87	0.87	1.90	0.79
Attention	7.46	0.96	6.44	1.45	6.23	1.80	6.70	1.54
Cued-recall	5.86	2.10	5.56	2.29	5.61	2.23	5.67	2.19
Recognition	8.00	1.63	7.07	1.77	7.56	1.43	7.55	1.64

Attention and memory. A one-way ANOVA with condition (control, visuospatial interference, verbal interference) as the between subject factor and the attention rating as the dependent variable was significant, $F(2, 83) = 5.88$, $f = 0.38$, $p < .01$. Post hoc tests with Bonferroni correction showed a significantly higher attention rating in the control condition compared to both interference conditions, both $p < .05$. The interference conditions did not differ significantly from each other, $p > .05$. The three conditions were comparable on cued-recall and recognition memory performance, $F(2, 83) = 0.15$, $p = .86$, respectively, $F(2, 83) = 2.60$, $p = .11$. The attention rating was significantly correlated with recognition memory, $r_s = .32$, $p < .02$, but not cued-recall memory.

Table 3. *Correlation coefficients (Spearman's Rho) between the frequency of intrusive images in and other PTSD symptoms*

	Intrusive visual images in diary	*Intrusive visual images in provocation task*
Intrusive images in provocation task	.36**	-
IES intrusion	.60**	.24*
IES avoidance	.36**	.10
Single-item avoidance	.33**	.21*
Memory fragmentation	.14	.22*
PTCI negative cognitions about self	.14	.03
PTCI negative cognitions about the world	.03	-.0.3
PTCI self blame	.25*	.10

** Significant at the .05 level, ** Significant at the .01 level*

Discussion

The main goal of this study was to explore whether intrusive *visual* images could develop from aversive *verbal* information when participants imagined the described scenarios. Our results clearly showed that participants developed intrusive visual images from imagining the traumatic journalist report. Furthermore, the participants reported a significant emotional impact from listening to the report. Thus, our findings suggest that *intrusive* visual images can indeed develop not only from direct visual input, but also from verbal descriptions of events. This indicates that, as earlier survey research and anecdotal reports have suggested, clinicians working with traumatized individuals may be at risk of developing intrusive images of their patients' trauma narratives. Our study has, for the first time to our knowledge, brought the investigation of intrusions of imagery into the laboratory.

We know that intrusions to directly perceived analogue trauma (i.e., an aversive film) can be selectively modulated by competing tasks (Holmes & Bourne, 2008). Thus, our second goal was to explore whether intrusive visual images from verbal information could be modulated by interfering with the encoding of the verbal narrative. Our results showed that intrusion frequency was reduced in both the visuospatial and verbal interference condition, compared to the no task control condition. This finding has implications for the field of secondary traumatisation and those at risk of developing symptoms. For example, clinicians working with traumatized individuals could benefit from performing a dual task when listening to the trauma narrative. Speculatively, writing therapy notes while listening to a trauma narrative in exposure therapy may help in this regard. From a theoretical point of view the results are more complex. Since this is, to our knowledge, the first study experimentally examining intrusive visual images from an aversive verbal report, our interpretation of the findings is still speculative.

Mental imagery research has shown that visuospatial competition reduces the vividness and emotionality of visual imagery whereas verbal competition does not (Baddeley & Andrade, 2000; Van den Hout, Muris, Salemink, & Kindt, 2001). This modality-specific effect does not appear in our results: first, there was no significant difference between conditions on the vividness and distress ratings of their imagery, indicating that the dual-tasks did not affect the imagery itself. Of course, it is possible that our imagery compliance check suffered from a lack of power to pick up any group differences. However, power-analyses (GPower 3.0.10) indicated that with the current results, a sample size of 495 would be required for imagery vividness and 1,854 for distress to show a significant difference between conditions. Another explanation is that imagery is especially vulnerable for modality-specific interference during encoding from a direct percept, or during memory retrieval, but not so much during imagery generated by incoming verbal information. In contrast to earlier imagery studies in which participants applied mental imagery during *retrieval* of for example a personal memory (Van den Hout et al., 2001), our participants were given specific *generation* instructions to use the incoming verbal information to generate experiences using mental imagery.

Interestingly, the competing resources tasks led to a difference in intrusion frequency. Participants in both the visuospatial and verbal interference condition reported lower intrusion frequency compared to those in the no task control condition. This indicates that the encoding of the imagery of the report was interfered by cognitive load, independent of modality. As discussed in the introduction, this is in line with predictions made by the SMS model of Conway and Pleydell-Pearce (2000) and does not support modality specific predictions made by the dual representation theory (Brewin et al., 1996). These models were not developed to explain intrusions of imagery and this interpretation is merely speculative. However, a similar pattern has been found in studies using a trauma film (Krans, Näring, & Becker, 2009) and IAPS pictures (Pearson et al., 2008) and is thus not unique to intrusions of imagery.

Our study has several limitations. The large majority of our participants were comprised of students. Given that they differed from the non-student participants on several measures (e.g., trait dissociation and trait anxiety), replication in a community sample is warranted. We focused on visual intrusions specifically, and therefore our results cannot be generalized to intrusive images from other modalities. Further, all participants were instructed to generate mental imagery when listening to the verbal report, but it is difficult to ascertain (as in other mental imagery studies; e.g., Baddeley & Andrade, 2000) how well participants were able to comply with this task. Methodological innovations such as fMRI may help in future studies. Future research should explore the role of mental imagery in more detail. For example, exploring variations of modality in input, intrusions, and mental imagery will be a very valuable enterprise.

In sum, our study showed that *intrusive* visual images can develop from *verbal* traumatic information and the frequency of these intrusions can be modulated. Our findings have practical implications. Clinicians working with PTSD patients may opt for employing a dual task during reliving sessions to prevent intrusion development, which may be useful in helping to reduce therapist “burnout” or at least the reluctance by some clinicians to conduct the exposure component of therapy for PTSD. Theoretically, our current results are more in line with a hierarchical model of autobiographical memory (e.g., Conway & Pleydell-Pearce, 2000) and not with dual-processing theories of PTSD (Holmes & Bourne, 2008).

Chapter 7

Eyewitness or earwitness: The role of mental imagery in intrusion development

This chapter is based on Krans, J., Näring, G., Speckens, A. E. M., & Becker, E. S. Eyewitness or earwitness: The role of mental imagery in intrusion development. *Manuscript submitted for publication.*

Abstract

Current cognitive theories of PTSD explain the development of intrusive visual images according to the encoding of the perceptual (visual) information of the traumatic event. However, recent studies have, under controlled circumstances, shown that visual intrusive images can also develop from listening to a verbal trauma report. The present study compared posttraumatic stress symptoms resulting from seeing versus listening to a trauma to help elucidate possible working mechanisms. Participants were randomly assigned to a film group or an imagery group. Participants in the film group were shown a trauma film of traffic accidents, whereas participants in the imagery group listened to a verbal report of this film and imagined the scenes. The main finding was that a preference for visual processing was positively related to intrusion frequency in the imagery condition but not in the film condition. In addition, participants in the imagery condition reported more avoidance and negative cognitions about the world after one week. Limitations and implications for the aetiology and treatment of intrusive traumatic memories are discussed.

Introduction

After a traumatic experience, people may suffer from recurring and distressing intrusive memories. For example, a person who was in a car accident may repetitively experience the image of approaching headlights preceding the accident (Ehlers & Clark, 2000). These intrusive images are a key feature of post-traumatic stress disorder (PTSD; American Psychiatric Association, 2000) and have also been acknowledged to play a role in other disorders such as depression (Starr & Moulds, 2006). Interestingly, it has also been found that listening to a description of such an event can lead to intrusive visual images as well (Krans, Näring, Holmes, & Becker, 2009b). Cognitive models of PTSD (e.g., Ehlers & Clark, 2000; Brewin, Dalgleish, & Joseph, 1996), however, assume direct visual input of a traumatic experience in the development of intrusive visual images. Thus, these models do not account for intrusive images that result from listening to a story, or so-called secondary traumatic experiences. Therefore, the present study aimed to help elucidate this process by examining potential differences in emotional impact, intrusive images, and other stress symptoms following an analogue traumatic event (i.e., a distressing film) versus a verbal description of that event.

The dual representation theory of PTSD (DRT; Brewin et al., 1996) states that intrusive images develop when there is a large discrepancy between the amount of information that has been consciously attended to during the trauma and information that was processed more automatically (Brewin et al., 1996). Accordingly, the information is stored in two memory systems. One system contains information that was processed automatically and consists of mostly sensory information but also cognitions formed at the time of trauma. This information is not integrated within autobiographical memory due to a lack of conscious conceptual processing, and is therefore automatically activated by perceptually similar cues, which is experienced as an intrusion. In contrast, elaborately processed information is integrated in autobiographical memory and recall is deliberately controlled (Brewin et al., 1996). The cognitive model of PTSD (Ehlers & Clark, 2000) states that intrusive images develop from an imbalance between peri-traumatic data-driven processing and conceptual processing. Whereas data-driven processing results largely in automatic encoding of perceptual features, conceptual processing attempts to assign meaning to the event and integrate the information within autobiographic memory. According to the PTSD models, the development of intrusive images is heavily determined by the way in which the direct sensory input of the traumatic event is stored and processed in memory.

Both models have been investigated empirically and have gained support (Holmes & Bourne, 2008). However, it is clear that neither can explain the development of intrusive images in the absence of the direct sensory input. Nevertheless, even *visual* intrusive images can develop from listening to the story of a traumatic experience (Krans et al., 2009b).

It is proposed here that mental imagery may play an important role in the development of intrusive images from a verbal report. A mental image exists “(…) when a representation of the type created during the initial phases of perception is present but the stimulus is not actually being perceived.” (Kosslyn, Thompson, & Ganis, 2006, p. 4). Mental imagery has been shown to have a strong link with emotion (Holmes & Mathews, 2005) and is thought to function as a preparation for an action response (Holmes, Geddes, Colom, & Goodwin, 2008). We suggest here that the trauma information is visually processed through mental imagery and that this underlies the development of intrusive images from a trauma narrative. If our hypothesis is supported, the occurrence of intrusive images may be more closely related mental imagery than cognitive models of PTSD suggest (e.g., Ehlers & Clark, 2000; Brewin et al., 1996). Specifically, the encoding and processing of *direct* (perceptual) trauma information that has been put forward as an important factor in intrusion development may actually play a less central role than suggested.

In the study by Krans et al. (2009b), participants were instructed to use mental imagery while listening to a verbal traumatic report. The main findings were that participants reported visual intrusive images of the report, and that intrusion frequency was reduced when a concurrent verbal or visuospatial task (compared to no extra task) was performed during the report. After this confirmation - that intrusive visual images can develop from listening to a traumatic verbal report - the current study aimed to elucidate what working mechanisms underlie this ‘secondary’ intrusion development. The data from the no-task control condition have been reported previously in Krans et al. (2009b). These data were compared here to data from a film group, tested specifically for this purpose. Participants in the film group viewed an often used stressful film showing road traffic accidents (RTAs) whereas participants in the imagery group listened to a verbal report of these traffic accidents. Mental imagery use and preference and the emotional impact of the film/report were assessed. Participants reported their intrusive images of the film/report in a one-week diary and returned for follow-up, when further self-report measures of stress symptoms were administered. It was hypothesized that mental imagery would be related to intrusion development in the imagery condition, but not in the film condition. In the latter group, the sensory (i.e., visual and auditory) information is presented to the participants and there is no need for mental imagery.

Method

Measures not relevant for the current study are reported in Krans, Näring, Holmes and Becker (2009b).

Participants

Participants were invited by e-mail to participate in exchange for course credit. As required by the ethics committee (CMO approval number 2005/063), participants were informed about the graphic content of the film/report (as in previous studies, e.g., Holmes, Brewin, & Hennessy, 2004) and went through a screening procedure. Exclusion criteria were: panic attacks, panic disorder (current and lifetime), PTSD, major depressive episode (current and lifetime), psychotic episode (current and lifetime), blood phobia, history of fainting and significant experience with road traffic accidents (RTA). The final sample consisted of 59 participants: 14 men and 45 women with a mean age of 21 years and 10 months (SD = 3.38).

Materials

Stressful film and report. The stressful film was originally compiled by Steil (1996). The version of Hagenaars, van Minnen, Holmes, Brewin, and Hoogduin (2008) was used, which includes the first four scenes of the original film. This version of the film lasts 11 min 42 sec and depicts graphic scenes of the aftermath of real-life RTAs that were videotaped in Germany. Each scene was introduced with a short spoken introduction about the victims and the outcome of the accidents. The film showed car wrecks, bloody wounds, dead bodies being moved, accompanied by sounds such as the screaming of the victims. The film was projected on a smooth white wall.

The eyewitness report (also 11 min 42 sec) was based on the RTA film. As a rationale, participants were told that they were going to listen to a reporter present at the scene who was making notes for later use using a voice-recorder. The background sounds of the original film were included in the recording. The reporter made particular mention of actions and details that had led to intrusions in previous experiments (e.g., Krans, Näring, Holmes, & Becker, 2010). The reporter spoke continuously and clearly became emotionally moved. The introductory remarks were the same as in the film. Participants used headphones to listen to the report and closed their eyes during imagery.

Questionnaires

Questionnaires and instructions were presented on a PC using Perseus® Software (Version 6).

Individual differences. Trait anxiety was measured with the Dutch version of the State-Trait Anxiety Inventory (STAI-T; Van der Ploeg, 1980). The STAI-T contains 20 items rated on a 4-point scale (1 = almost never, 4 = almost always). The STAI-T has a high test-retest reliability and internal consistency (Van der Ploeg, 1980). To measure to what extent participants spontaneously use imagery in daily life, the Spontaneous Use of Imagery Scale (SUIS; Reisberg, Pearson, & Kosslyn, 2003) was administered. This questionnaire consists of 12 items, rated on a 5-point scale (1 = never appropriate, 5 = always completely appropriate). The SUIS has high internal consistency and convergent validity (Reisberg et al., 2003). Preference of cognitive processing style (verbal/visual) was measured with the Verbalizer-Visualizer Questionnaire (Richardson, 1977). This widely used questionnaire consists of 15 items (7 for verbal processing, 8 for visual processing) and has acceptable stability and reliability. Following recommendations in the literature (Childers, Houston, & Heckler, 1985), the original response format true/false was changed to a format consisting of a 7-point scale (1 = totally agree, 7 = totally disagree).

Control measures

Compliance. Participants in the imagery condition received a short imagery training in field perspective (Holmes, Coughtrey, & Connor, 2008), and rated the vividness of their imagery on a 4-point rating scale (1 = totally disagree, 4 = totally agree). Attention for the film/report was rated on an 11-point scale (0 = not at all, 10 = completely). To check compliance with the intrusion diary, participants rated the statement: “I have often been unable (or have forgotten) to record my intrusive images in the diary" on an 11-point scale (0 = not at all, 10 = very much; Holmes et al., 2004).

Emotional impact of the film/report. Negative mood was measured with a questionnaire (MoodQ) consisting of five items rating current happiness, anxiety, horror, depressed mood, and anger on an 11-point scale (0 = not at all, 10 = extremely; Holmes et al., 2004). The Dutch version of the state version of the STAI (STAI-S; Van der Ploeg, 1980) was used to measure state anxiety. The STAI-S consists of 20 items rated on a 4-point scale (1 = not at all, 4 = very much).

Experimental measures

Intrusive images. Participants reported their intrusive images in a diary during the week following the first session. They were required to write down all intrusions the moment they occurred and to check the diary at a fixed time everyday. The cover page of the diary contained instructions and a definition of intrusions. Each entry in the diary allowed the participant to write down the content of the intrusion, the modality (sensory [visual, auditory] or verbal), and associated distress (0 = not at all, 10 = extremely). At follow-up, intrusive experiences were measured with the Intrusion subscale of the revised version of the Impact of Event Scale (IES_Intrusion; Horowitz, Wilner, & Alvarez, 1979, Dutch version by TZP Psychotrauma, 2006). This subscale consists of 8 items rated on a 4-point scale (0 = not at all, 3 = often) and has adequate reliability and validity (Olde, Kleber, van der Hart, & Pop, 2006).

Other PTSD symptoms. Avoidance (8 items) and hyperarousal (6 items) symptoms during the week between the first session and follow-up were measured with the Dutch translation of the revised version of the IES (TZP Psychotrauma, 2006). Post-traumatic cognitions about the film/report were measured with the Post-Traumatic Cognitions Inventory (PTCI; Foa, Ehlers, Clark, Tolin, & Orsillo, 1999). The PTCI consists of three subscales measuring negative cognitions about the self (21 items), negative cognitions about the world (7 items), and self-blame (5 items). Answers are given on a 7-point scale (1 = totally disagree, 7 = totally agree).

Procedure

After screening, participants signed an informed consent form stating that they were informed about the nature of the study and the exclusion criteria. They also received the telephone number and address of a local mental health care centre in case of distress caused by participation (no participants contacted the facility). Participants filled in a demographic questionnaire (age, gender, and education), the SUIS, STAI-T, STAI-S, and the MoodQ. Participants were randomly assigned to one of the two conditions (film, imagery). Participants in the imagery condition received a short imagery training in field perspective (Holmes et al., 2008) and rated the vividness of their imagery. All participants received written instructions for the appropriate experimental condition. Participants in the film condition were instructed to view the film as if they were witnesses to the scene. Participants in the imagery condition were instructed to imagine that they were witnesses at the scene. All participants were instructed not to look away or mentally disengage from the film/report. The film or mp3 was started and the experimenter left the room. Afterwards, participants filled in the MoodQ, STAI-S, the attention rating, and were given the intrusion diary. Participants returned for follow-up one week later and filled in the diary compliance rating, IES, and PTCI. Finally, participants were debriefed and thanked for their involvement.

Statistical approach

The data were checked for univariate and multivariate outliers across and within conditions. There were no multivariate outliers according to Mahalanobis distances. There were seven univariate outliers (more than three standard deviations from the mean), and these were adjusted according to the procedure described by Tabachnick and Fidell (1996). There were two randomly missing values, which were excluded from the analysis.

Differences in discrete variables were tested using Chi-square analysis. Differences in continuous variables between the imagery and film condition were tested with independent samples *t*-tests. In case of significant differences in variance, corrected *t*-values are reported. Correlations with intrusion frequency were ranked (Spearman) because of non-normal distribution. An $\alpha = .05$ was the level of significance in all tests. Effect sizes are reported as Cohen's *d* and *f*.

Results

Demographic variables

The imagery and film condition did not differ with respect to age, $t(57) = 0.31$, $p = .76$, gender, $\chi^2(1) = 1.68$, $p = .20$, and educational level, $\chi^2(2) = 3.70$, $p = .16$, see Table 1.

Individual differences

Participants in the imagery and the film condition were comparable on the trait measures (STAI-T, SUIS, VVQ visual, VVQ verbal); all $t(57) < 1.38$, all $p > .17$, See Table 1.

Compliance check

Participants in the imagery condition rated the vividness of their imagery training as $M = 2.97$, $SD = 0.50$. Attention rating for the film/report was comparable between conditions, $t(57) = 1.61$, $p = .11$, and was overall high. Diary compliance was slightly better in the film condition, $t(57) = 2.03$, $p = .05$, but was overall good.

Table 1. *Descriptive statistics of control measures across and within conditions*

		Imagery condition		*Film condition*		*Total*	
Measure		*M**	*SD*	*M**	*SD*	*M**	*SD*
Age		21.69	2.73	21.97	3.95	21.83	3.38
Gender	Men	9	-	5	-		
	Women	20	-	25	-		
Education	University	22	-	28	-		
	HBO**	1	-	0	-		
	Other	6	-	2	-		
STAI-T		36.21	8.01	34.40	6.77	35.29	7.40
SUIS		39.72	6.46	37.67	7.36	38.68	6.95
VVQ visual		34.76	4.73	35.77	7.01	35.27	5.97
VVQ verbal		32.79	3.36	34.10	3.92	33.46	3.68
Imagery vividness		2.97	0.50	-	-	-	-
Attention for film/report		8.48	0.95	8.97	1.33	8.73	1.17
Diary compliance		3.17	1.79	2.27	1.64	2.71	1.76

* Except for Gender and Education, which are summed scores ** Higher vocational education

Emotional impact of the film/report

To test the emotional impact of the film/report, a 2 Time (baseline, post-film/report) x 2 Condition (imagery, film) mixed ANOVA was performed with Time as a within-subjects factor, Condition as a between-subjects factor, and negative mood (MoodQ) as the dependent variable. There was a significant main effect of Time, $F(1, 57) = 38.82$, $p < .01$, $f = 0.78$, indicating an increase in negative mood from baseline to post-film/report across conditions, see Table 2. The main effect of Condition and the Time x Condition interaction did not reach significance, both $F(1, 57) < 2.91$, both $p > .09$.

A 2 Time (baseline, post-film/report) x 2 Condition (imagery, film) mixed ANOVA with state anxiety (STAI-S) as the dependent variable, showed an overall increase in state anxiety from baseline to post-film/report, as indicated by a significant main effect of Time, $F(1, 57) = 38.90$, $p < .01$, $f = 0.83$. The main effect of Condition and the Time x Condition interaction did not reach significance, both $F(1, 57) < 1.79$, both $p > .18$.

Table 2. *Descriptive statistics of experimental measures across and within conditions*

		Imagery condition		*Film condition*		*Total*	
Measure		*M*	*SD*	*M*	*SD*	*M*	*SD*
MoodQ	Baseline	10.35	3.63	10.93	3.84	10.64	3.72
	Post-film/report	14.14	5.62	17.30	7.43	15.75	6.74
STAI-S	Baseline	32.45	6.98	32.80	7.34	32.63	7.10
	Post-film/report	36.83	8.59	39.57	9.76	38.22	9.23
Intrusive visual images		5.59	4.54	6.47	5.20	6.03	4.86
Intrusive auditory images		0.24	0.58	0.17	0.38	0.20	0.48
Intrusion distress		2.87	1.88	2.27	1.68	2.56	1.79
IES_Intrusion		0.70	0.38	0.61	0.43	0.66	0.40
IES_Avoidance		0.51	0.27	0.26	0.37	0.38	0.34
IES_Hyperarousal		0.18	0.26	0.10	0.16	0.14	0.22
PTCI_Negative cognitive about self		1.64	0.50	1.51	0.37	1.57	0.44
PTCI_Negative cognitions about the world		2.95	1.07	2.50	0.82	2.72	0.97
PTCI_Self blame		1.99	0.75	1.88	0.82	1.94	0.78

Experimental measures

Intrusive images. In total, 356 visual intrusive images and 12 auditory intrusive images were reported. There was no significant difference in the frequency of intrusive images between the two conditions per modality (visual or auditory) or in total, all $t(57) < 0.70$, all $p > .49$. This was confirmed by a similar test on the IES_Intrusion subscale, $t(57) = 0.86$, $p = .40$. Intrusion distress was also comparable for both conditions, $t(54) = 1.25$, $p = .22$. Given the low number of auditory intrusive images and theoretical considerations, further analyses were done for the visual intrusive images only.

Across participants, the frequency of intrusive visual images was significantly and negatively correlated with the spontaneous use of imagery (SUIS), $r_s = -.26$, $p = .05$. Within the imagery condition only, frequency of intrusive visual images was significantly and positively correlated with visual processing style (VVQ visual), $r_s = .41$, $p = .03$, but not with verbal processing style (VVQ verbal), $r_s = -.04$, $p = .83$. In the film condition, processing style (VVQ visual and verbal) was not related to the frequency of intrusive visual images, both $p > .10$.

Other PTSD symptoms. Participants in the imagery condition reported significantly more avoidance (IES) than participants in the film condition, $t(57) = 2.97$, $p < .01$, $d = 0.79$, and marginally significantly more negative cognitions about the world (PTCI), $t(57) = 1.80$, $p = .08$, $d = 0.30$. There were no significant differences between conditions on hyperarousal (IES), $t(54) = 1.43$, $p = .16$, negative cognitions about self (PTCI), $t(54) = 1.16$, $p = .25$, or self blame (PTCI), $t(54) = 0.55$, $p = 0.58$.

Discussion

In line with our expectation, preference for a visual processing style was related to intrusion frequency in the imagery condition, but not in the film condition. This finding supports the hypothesis that mental imagery plays a role in the development of intrusive images in the absence of direct visual input. A preference for verbal processing was unrelated to intrusion development, which is in line with the finding that the large majority of intrusions in the diary were visual in nature. Interestingly, spontaneous use of imagery (SUIS) was negatively correlated with intrusion frequency across the conditions. We do not have a simple explanation for this finding at this point, but it inspires the exciting suggestion that there may be different forms of mental imagery that relate to intrusion development in different ways.

Surprisingly, the film and the report increased negative mood and state anxiety to a comparable extent, and no significant differences in intrusion frequency or intrusion distress were found. Direct sensory input (with a mild stressor) does not appear to be a necessary factor for the development of intrusive images. Given the analogue design, our findings do not rule out the importance of direct input from an actual traumatic event. The lack of a significant difference between the imagery and the film condition in respect to emotional impact, intrusion frequency and distress may also be due to lack of power. The power for the statistical between-group tests for these specific variables varied from 1-ß = 0.10 (for intrusion frequency) to 0.44 (for the MoodQ), suggesting a required sample size of 228 to 1.602, respectively (calculations done with GPower 3.1). If anything, these effects would be small.

Interestingly, participants in the imagery condition showed higher avoidance and negative cognitions about the world compared to the film condition. Self-relevance of the information may be an important concept here. Viewing a film of traffic accidents happening to other people may be distressing but does not have direct personal relevance or consequence for the viewer. In the imagery condition, however, participants will mostly rely on information from personal learning experiences and knowledge to imagine the RTAs scenery from the verbal report. Self-generated images may be more self-relevant by definition (Conway & Pleydell-Pearce, 2000). Accordingly, more avoidance and negative cognitions about the world were found in the imagery condition. This may be a result of the information being more self-relevant to them than viewing other people having car accidents on a video. This interpretation is indirectly supported by the fact that almost half of the reported intrusions were from a scene in which the RTA victim is a student underway to her parents (the other scenes were about families or elderly people). Our participants were mostly female students, so identification with this victim was perhaps more likely. The results have to be interpreted carefully, however, as the IES and PTCI findings necessarily do not reflect change scores but follow-up scores.

The present study has several limitations. First, we used a stressful film as an analogue traumatic stressor. Therefore, we cannot generalize to actual trauma and we do not believe that our results will. Our main theoretical conclusion is that direct sensory input is not a necessary factor for intrusion development, which broadens the scope of cognitive models of PTSD (Ehlers & Clark, 2000; Brewin et al., 1996). Our findings may also support the notion that, although peri-traumatic processing may be important, self-relevance of the information is a key feature in intrusion development. This view is in line with the Self-Memory System (Conway & Pleydell-Pearce, 2000) in which intrusive memories are thought to reflect personally relevant active goals that are challenged by the traumatic event. Future research should further explore the relative importance of both peri-traumatic processing and self-relevance of the trauma information in intrusion development. Second, participants in the imagery condition received an imagery training whereas participants in the film group did not. It is possible that the training and not the nature of the analogue trauma (i.e., visual film material or auditory report material) caused the differences between the conditions. However, this would still support the role of mental imagery in the development of intrusive images. Nevertheless, it would be more elegant to include a no training imagery condition in future studies. Our results do not inform about how mental imagery would be used spontaneously when listening to a trauma narrative.

To summarise, the present study showed that a preference for visual processing is associated with higher levels of intrusive visual images from secondary “trauma” information. Whereas cognitive models of PTSD (Ehlers & Clark, 2000; Brewin et al., 1996) have stressed peri-traumatic information processing as an important factor for intrusion development in trauma, it is possible that self-relevance of stressful information is even more important to predict intrusion development (as suggested by Conway & Pleydell-Pearce, 2000). However, this hypothesis clearly needs further testing in a study manipulating the extent of self-relevance of the traumatic material. From a practical viewpoint, professionals with a high preference for visual processing may have a higher risk of developing unwanted intrusive images when working with traumatized patients than others. Perhaps interventions to reduce the vividness of imagery during sessions can be helpful.

Chapter 8

Suppress ability and suppressability of intrusive and non-intrusive images

This chapter is based on Krans, J., Näring, G., & Becker, E. S. Suppress ability and suppressability of intrusive and non-intrusive images. *Manuscript submitted for publication.*

Abstract

The present study contrasted intrusiveness as a characteristic of negative images with intrusiveness as occurrences in awareness due to thought suppression. These definitions of 'intrusions' are often confounded, although they stem from different cognitive processes. Suppression success was compared for a negative intrusive image, a negative non-intrusive image from the same event, and a non-intrusive negative image from another event. We explored how the ability to suppress these targets related to persistent intrusive images. Participants viewed a stressful film and reported intrusive images of the film in a one-week diary. On their return, they performed a suppression task consisting of a baseline, suppression, and post-suppression phase. Occurrences of the to-be-suppressed images during suppression were positively correlated with intrusive images in the diary. Occurrences of the intrusive image post-suppression were also related to the number of intrusive images in the diary. These findings suggest that both individual differences and specific imagery characteristics are important in the relationship between thought suppression and persistent intrusive images. Our results support the argument that intrusive images of a negative experience should not be confused with intrusions due to thought suppression efforts.

Introduction

Recurring unwanted (i.e., intrusive) images of a traumatic event are a key feature of post-traumatic stress disorder (PTSD; American Psychiatric Association, 2001). As they are highly distressing, it is not surprising that trauma survivors make a great effort to suppress these images. However, suppression of a cognition can result in an ironic increase in that very cognition (Wegner, 1994). Several studies have employed the thought suppression paradigm to investigate intrusive trauma memories. However, the difference between persistent intrusive memories and intrusive occurrences as an effect of efforts to suppress is more often than not ignored. This is highly surprising, because the intrusive character of an image stems from a different cognitive process than thought suppression effects per se. Cognitive theories of PTSD (Brewin, Dalgleish, & Joseph, 1996; Ehlers & Clark, 2000) state that the intrusive nature of an image is determined by the initial encoding of the traumatic information. The information is encoded as an image-based representation that is not well integrated in autobiographical memory, and is automatically activated by relevant cues resulting in intrusive images or ‘flashbacks’. Thus, *the intrusive nature* is thought to be determined by the initial encoding of the trauma information in memory. Subsequently, people may try to suppress the distressing images, which in turn can result in an increase of the images in awareness (i.e., thought suppression effect). In line with this distinction, Rassin, Merckelbach, and Muris (2001) found that a theoretical model in which thought suppression was not causally related to the intrusive character provided the best fit for the memories of negative events reported by graduate students. There has been a trend in the thought suppression literature for “intrusions” to be used as an umbrella term. In contrast, the present study distinguished between two definitions of “intrusions”: (i) *intrusive images*, as persistent unwanted and uncontrollable images of a (negative) event, and (ii) occurrences of a to-be-suppressed target in awareness due to thought suppression effects.

Effects of thought suppression have been described by Wegner (1994). During suppression, an effortful intentional operating system searches for mental content that will lead to the desired state; thus, anything but the to-be-suppressed target. A monitoring process scans for failures of this process by searching for the to-be-suppressed target in the mental contents. However, by searching for the avoided target, occurrences of that target may ironically enter awareness. In a typical thought suppression study (as proposed by Wegner, Schneider, Carter III, & White, 1987), participants are instructed to suppress, express, or monitor a target in awareness. Increases in occurrence of the target in awareness during suppression compared to monitoring are defined as an immediate enhancement effect. Increases after suppression compared to the suppression and monitoring phases are defined as a rebound effect (Abramowitz, Tolin, & Street, 2001).

Research has linked together the intrusive character of traumatic memories and the ironic thought suppression processes (Wegner, 1994). For example, thought suppression was found to be a major predictor of PTSD (Ehlers, Mayou, & Bryant, 1998), and seems to be a coping style specifically endorsed in PTSD (Amir et al., 1997). Several studies have used trauma-related targets in a thought suppression paradigm. For example, a rebound effect of trauma-related thoughts was found in PTSD patients (Shipherd & Beck, 2005) and acute stress disorder patients (Harvey & Bryant, 1998a). A small number of studies using an aversive film as an analogue traumatic event have been carried out to study effects of this type of thought suppression experimentally. Davies and Clark (1998) presented participants with a positive film on polar bears and a negative film about a disaster. Half of the participants were instructed to suppress thoughts of the film for two minutes, followed by a post-suppression monitor phase of two minutes. The other half of the participants merely monitored their thoughts. The results showed an initial decrease of occurrences in awareness of both films during suppression, and a rebound effect for the disaster film but not the polar bear film. Nixon, Cain, Nehmy, and Seymour (2009) showed participants an aversive film and instructed one group of participants to suppress thoughts about the film whereas another group merely monitored their thoughts. At one-week follow-up, participants monitored their thoughts again. There was no difference in occurrences of targets between these two groups. Harvey and Bryant (1998b) showed participants a violent, humorous or neutral film. Half of the participants were allocated to a suppression condition. Overall, the distressing film elicited more occurrences than the neutral film, and for all film groups a similar rebound effect was found. Overall, studies of "intrusions" and thought suppression in the context of (analogue) traumatic memories have yielded mixed results.

The interchangeable use of the term "intrusions" to refer to both a characteristic of a cognitive unit and a result of thought suppression is problematic. Further, most studies have instructed participants to suppress (analogue or actual) *trauma-related thoughts*, which is unclear of itself. This instruction does not distinguish, for example, verbal thoughts (e.g., "I am going to die") from visual images (e.g., "the face of the perpetrator"), and it cannot be assumed that suppression effects are identical for all types of cognitive units. For these reasons we explored suppression effects for emotional *images* that differ in the extent to which they have an intrusive *character*.

Our participants viewed a stressful film and reported intrusive images of the film in a diary during the week after film viewing. Participants then performed a suppression task. They suppressed the most frequent and distressing intrusive image from the diary, another scene from the film, and a negative control image. Cognitive models of PTSD (e.g., Brewin et al., 1996; Ehlers & Clark, 2000) suggest that intrusive images are hard to control deliberately due to the nature of the initial encoding. Therefore, we hypothesized that occurrences of the intrusive image of the film in awareness would be higher (1) during and (2) after suppression compared to the two other targets. Based on the ironic process theory (Wegner, 1994), we expected that none of the targets could be suppressed completely. Further, we expected that success of suppression of the intrusive image would be a valid indication for the day-to-day controllability of the intrusive image. Thus, the frequency of occurrence of the intrusive image during and after suppression was expected to be related to the number of intrusive images in the diary. We did not expect any differences between the non-intrusive film image and the control negative image. We used a within-subjects design to test our hypotheses. Our research question does not involve specific initial enhancement or rebound effects and thus does not call for a no-suppression control group.

Method

Participants

Data collection was part of a larger project (Krans, Näring, Holmes, & Becker, 2009a). Participants were students from the Radboud University Nijmegen. Exclusion criteria were: panic attacks, panic disorder, PTSD, major depressive episode, psychotic episode, blood phobia, history of fainting and history of road traffic accidents (RTAs). The inclusion criterion was at least one intrusive image of the film reported in the diary. Twenty-eight participants who fulfilled criteria completed the thought suppression task. The mean number of intrusive images in the diary was $M = 3.29$, $SD = 2.54$. The mean age was 19 years and 6 months ($SD = 1.37$), 20 participants were female and 8 were male.

Materials

Trauma film. Four film clips showing RTAs were used (Hagenaars, van Minnen, Holmes, Brewin, & Hoogduin, 2008). These clips involved scenes such as dead bodies being moved and injured victims screaming. The film clips were divided into blocks and shown in counterbalanced order for purposes not relevant for this study (see Krans et al., 2009a, for details). The film was 12 min and 38 sec long and all clips were preceded by a short verbal introduction providing information about the event, the victims and the outcome. The film was projected on a smooth white wall and sound was provided through headphones.

Measures

Control measures and manipulation check. Attention for the film was self-rated with a single-item measure on an 11-point scale (0 = not at all focused on the film, 10 = completely focused on the film). The emotional impact of the film was measured with a Mood Questionnaire (MoodQ; Holmes, Brewin, & Hennessy, 2004) and the Dutch version of the State Trait Anxiety Index-State version (Zelfbeoordelingsvragenlijst; Van der Ploeg, 1980). The MoodQ is a self-report questionnaire with five items measuring current happiness, anxiety, horror, depressed mood and anger on an 11-point scale (0 = not at all, 10 = extremely). The STAI-S consists of 20 items of state anxiety that are self-rated from 1 (not at all) to 4 (very much).

Intrusive images of the film. Participants reported their intrusive images of the film in a one-week diary (Holmes et al., 2004). A page was provided for every day and participants were required to write down a brief description of the content of their intrusive images. Diary compliance was measured with a self-report single-item scale from 0 (never forgot to write down the intrusion) to 10 (always forgot to write down the intrusion) as in Holmes et al. (2004).

General procedure

The experiment consisted of two sessions, one week apart. Participants were screened for exclusion criteria and signed written informed consent. They were given a demographic questionnaire, the MoodQ, and the STAI-S on a PC using Perseus® software (Version 6). Participants viewed the trauma film with the instruction not to look away or to mentally disengage from the film, and to view the film as if they were a witness to the scene. After film viewing, the MoodQ, STAI-S and attention rating were completed, and participants were given the intrusion diary. During the week after the first session participants reported their intrusive images of the film in the diary and then returned for the second session. The diary compliance rating was administered and the suppression task was started. Finally, participants were thanked and assigned course credit for participating.

Suppression task

Suppression effects were compared for three targets: (a) the main intrusive image of the film reported in the intrusion diary (Intrusive image), (b) a well-remembered scene from the film that was not the main intrusive image (Scene), and (c) a negative control image (Control). For the main intrusive image, participants were asked to select the most important image intrusion in their diary, defined as the most frequent and stressful image. All participants in the current study remembered two scenes from this particular film ('screaming student on stretcher' and 'bloody knee wound'). When the participant reported the 'screaming student on stretcher' as the main intrusive image, the 'bloody knee wound' image was chosen as well-remembered scene and vice versa. 92.86% of the participants in the current study reported either one if these scenes as their main intrusive image, whereas 7.14% reported another scene as their main intrusion, although they all had experienced one of the two scenes as intrusive. For the negative control image, participants were asked to form an image of themselves drowning.

To ensure that participants were clear what the specific targets were, participants were asked to close their eyes and to imagine the targets as vividly as possible. When the participant indicated that the image was experienced most vividly, the next target was imagined. The order of the targets was counterbalanced.

In the suppression task, the first phase was a Baseline measurement. Participants were instructed to do the following:

> "After the experimenter has left the room, please think out loud for two minutes. Verbalize everything that comes into your mind. This could be a description of an image, memories, feelings, fantasies, plans, sensations, observations, daydreams, objects that catch your attention, or attempts at solving a problem. It could be something else as well.
> Please verbalize continuously during these two minutes. This is important. After two minutes the experimenter will enter the room and you can stop.
> The experimenter cannot hear what you are saying, but it will be recorded. The information will be treated confidentially and anonymously. Do you have any questions?"

After the Baseline measurement, three Suppression phases followed in counterbalanced order. In one of the Suppression phases, participants were required to suppress their main intrusive image from the diary. Instructions were as follows:

> "After the experimenter has left the room, please think out loud for two minutes again. This time, however, try not to think about the intrusive image that you discussed with the experimenter. However, if you do, verbalize these thoughts out loud as well. Every time you think about the intrusive image please also press the allocated button."

In another Suppression phase participants were required to suppress the image of the film scene that was not the main intrusive image ('screaming student on stretcher' or 'bloody knee wound'). The instructions were the same for suppressing the intrusive image except that participants were required not to think about "the scene from the film" instead of the intrusive image. In a third Suppression phase, participants were required to suppress the Control image. In between the three Suppression phases, participants worked on a word finding puzzle as a distraction task for two minutes to minimize fatigue and carry-over effects from the suppression task. Although not an actual phase in the task, we also scored the number of occurrences of every target during the suppression of the other two targets. This phase is indicated as Suppression of other Target in the results section.

After the three suppression phases, participants were required to think out loud for two minutes again (Post-suppression phase) with the following instructions:

> "After the experimenter has left the room, please think out loud for two minutes again. This time you can think about anything, including the intrusive image, the film scene and the image of drowning. Just verbalize everything that comes into your mind. Please continuously verbalize during these two minutes. This is important. Additionally, please press the button each time you happen to think about the intrusive image, the film scene, or the image of drowning."

Occurrences of the three targets were measured using an audio-recording with an unobtrusive microphone during the Baseline measurement (button presses were not possible since there had been no instruction of suppression yet). Occurrences of the to-be-suppressed target in the Suppression phases were measured with both audio-recording and button presses. Occurrences of the non-suppressed targets in the suppression phases (Suppression of Other Target) was scored with the audio-recording (participants were not required to press a button for non-suppressed targets). In the Post-suppression phase, occurrences of the three targets were measured by audio-recording and button press. Participants were required to press the same button for all three targets to avoid cognitive load.

Results

Outliers and statistical approach

The data was scanned for multivariate and univariate outliers according to the procedure described by Tabachnick and Fidell (1996). No multivariate outliers were detected using Mahalanobis distances. Two univariate outliers were identified that were three standard deviations from the mean. These outliers (occurrences of Scene during Suppression, occurrences of Scene during Post-suppression) were adjusted to the first unit that was not an outlier (Tabachnick & Fidell, 1996).

Suppression effects were tested using repeated measures ANOVA. Within-subject effects were further explored using paired-samples t-tests. Relations with the number of intrusive images in the diary were calculated using Spearman correlations as the diary measure was not normally distributed. An alpha level of .05 was considered as the threshold of significance in all tests.

Control measures and manipulation check

The mean attention rating was $M = 8.75$, $SD = 1.17$, indicating high attention for the film. Paired-samples t-tests indicated a significant increase in negative mood (MoodQ), $t(27) = 3.31$, $p < .01$, $d = 0.76$, and state anxiety (STAI-S), $t(27) = 3.34$, $p < .01$, $d = 1.35$, from pre- to post-film. Control measures and intrusive images in the diary are displayed in Table 1.

Table 1. *Means and standard deviations for individual differences and control measures*

Measure (n = 28)		*M*	*SD*
Attention		8.75	1.17
STAI-S	pre-film	33.36	5.81
	post-film	38.04	7.94
MoodQ	pre-film	10.25	4.01
	post-film	14.04	5.98
Diary intrusive images		3.29	2.54

To check reliability of the occurrence measures in the suppression task, we correlated the audio-recording and the button presses for each to-be-suppressed target in the Suppression phases. These correlations were high (all > $r = .86$). For the Post-suppression phase, the number of button presses was equally highly correlated with the summed frequency of the three targets in the audio-recording, $r = .90$. To ensure the highest inclusion rate, the highest frequency (audio or button press) was used for every target/phase combination.

To check for possible order effects, ANOVAs were performed with the suppression task order as the independent factor and occurrences per target/phase combination as the dependent variable. These analyses indicated no order effects for any of the targets in any of the phases (all < $F(5, 22) = 2.28$, all $ps > .08$).

Experimental measures

Suppression effects were tested with a 3 Target (Intrusive image, Scene, Control) x 4 Phase (Baseline, Suppression, Suppression of other Target, Post-suppression) repeated measures ANOVA with Target and Phase as within-subject factors and intrusion frequency as the dependent variable. There was a significant main effect of Target, $F(2, 26) = 8.89$, $p < .01$, $f = 0.83$; a significant main effect of Phase, $F(3, 25) = 24.32$, $p < .001$, $f = 1.71$; and a significant Target x Phase interaction, $F(5, 23) = 6.11$, $p < .01$, $f = 1.15$. There were no carry-over effects, as correlations between the different phases per target did not reach significance (largest $r_s = .19$, $p = .34$). The Target x Phase interaction was followed up with paired-samples t-tests comparing intrusion frequency between Phases for each Target and between Targets for each Phase. Means and standard deviations are displayed in Table 2 and Figure 1.

Table 2. *Means and standard deviations for the occurrence per Phase for each Target of in the suppression task*

	Intrusive memory Target		*Scene Target*		*Control Target*	
Phase	*M*	*SD*	*M*	*SD*	*M*	*SD*
Baseline	0.36	0.49	0.00	0.00	0.00	0.00
Suppression	2.50	2.20	2.07	1.80	2.32	1.96
Suppression other Target	0.00	0.00	0.00	0.00	0.00	0.00
Post-suppression	0.71	0.76	0.21	0.42	0.68	0.72

Phase effect. For the Intrusive image target, occurrences in the Suppression phase, $M = 2.50$, $SD = 2.20$, were significantly higher than in the three other phases, all $t(27) > 4.51$, all $p < .001$, all $d > 1.21$. Occurrences in the Post-suppression phase, $M = 0.71$, $SD = 0.76$, were significantly higher than the Suppression of other Target and Baseline phases, all $t(27) > 2.17$, all $p < .04$, all $d > 0.56$. Finally, occurrences in the Baseline phase, $M = 0.36$, $SD = 0.49$, were significantly higher than during the Suppression of other Target (the intrusive memory was not mentioned by any of the participants), $t(27) = 3.87$, $p < .01$, $d = 1.47$.

For the Scene target, occurrence was significantly higher in the Suppression phase, $M = 2.07$, $SD = 1.80$, compared to the other three phases, all $t(27) > 5.28$, all $p < .001$, and all $d > 1.68$. Occurrence was significantly higher in the Post-suppression phase, $M = 0.21$, $SD = 0.42$, compared to the Baseline and Suppression of other Target phase, both $t(27) = 2.71$, $p = .01$, $d = 1.00$. No occurrences of the film Scene were reported during the Baseline phase or during Suppression of other Targets.

For the Control image, occurrence was significantly higher in the Suppression phase, $M = 2.32$, $SD = 1.96$, compared to the three other phases, all $t(27) > 4.55$, all $p < .001$, and all $d > 1.22$. Occurrence was significantly higher in the Post-suppression phase, $M = 0.68$, $SD = 0.72$, compared to the Baseline and Suppression of other Target phase, both $t(27) = 4.97$, $p < .001$, both $d = 1.89$. No occurrences of the Control image were reported during Baseline measurement or during suppression of the other two targets.

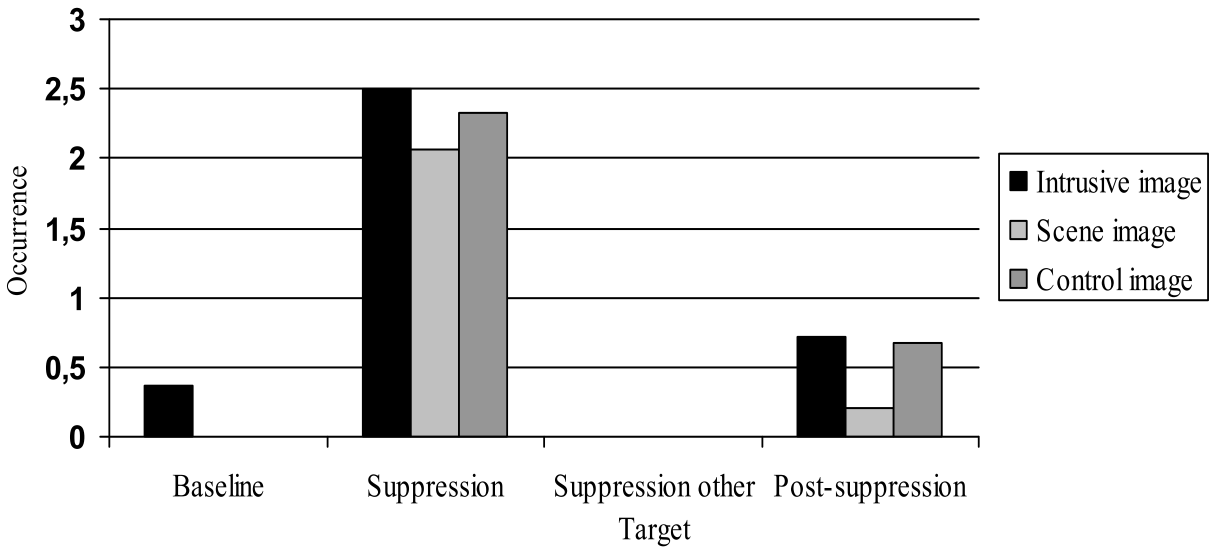

Figure 1. Mean occurrence of the different Targets (Intrusive memory, Scene, Control) in every Phase (Baseline, Suppression, Suppression other Target, Post-suppression).

Target effect. Occurrence of the Intrusive image was significantly higher than the other two targets in the Baseline phase, both $t(27) = 3.87$, $p < .01$, $d = 1.47$. There were no occurrences of the Scene or Control image in this phase. In the Suppression and Suppression of other Target phase, there were no significant differences in the occurrence of the targets, all $p > .05$. In the post-suppression phase, occurrence of Scene was significantly lower than that for Intrusive memory and the Control image, all $t(27) > 3.30$, all $ps < .01$, all $d > .082$; without a significant difference between the latter, $p > .05$.

Intrusive images in the diary. The number of intrusive images of the film that participants reported in the diary was highly significantly related to target occurrence during Suppression: Intrusive image $r_s = .94$, $p < .001$, Scene $r_s = .74$, $p < .001$, and Control $r_s = .64$, $p < .001$; and to occurrence of the Intrusive image during the Post-suppression phase, $r_s = .57$, $p < .01$, but not to any other variables.

Discussion

We hypothesized that occurrence (1) during, and (2) post-suppression would be higher for the intrusive image than for the scene and control image. The data only partially supported the hypothesis. First, during suppression, occurrences were equally high for all three targets. This indicates that (negative) images may be hard to suppress, irrespective of intrusive or non-intrusive character. Although unexpected, this supports a distinction between intrusiveness as a characteristic of an image and intrusiveness as occurrences of a target in awareness due to suppression. Our expectation that the three targets could not be suppressed completely was confirmed, supporting the ironic process theory (Wegner, 1994).

Second, occurrence of the intrusive image was significantly higher than the scene target at post-suppression. Once activated, the intrusive image remained active longer than the scene target. This is in line with information processing theories (e.g., Brewin et al., 1996; Ehlers & Clark, 2000) suggesting that intrusive images are harder to control deliberately. The prolonged activation may indicate that intrusive images are meaningful in a sense that their discrepancy with our current goals and beliefs is not resolved and they are thus goal-relevant (Conway & Pleydell-Pearce, 2000). This argument is supported by the finding that occurrence of the intrusive image was significantly higher during baseline than the other two targets, that did not come into awareness at all during baseline. The lack of a difference between occurrence of the intrusive image and the control image in the post-suppression phase was unexpected. Whereas the intrusive image and the scene image refer to a specific image, the instruction to generate an image of drowning may not have resulted in an equally specific image. Abramowitz et al. (2001) showed that non-discrete targets showed higher rebound effects than discrete (i.e., more specific) targets. Although we did not measure a rebound effect, it is possible that the control target remained active after suppression because the instruction to image oneself drowning might have lead to a less specific image than a film scene. Alternatively, it is possible that the self-generated image of drowning lead to similar characteristics as the intrusive image. Krans, Näring, Holmes, and Becker (2009b) found that self-generated images from an aversive verbal report developed into intrusive images during the subsequent week. Thus, it is possible that the drowning imagery led to sensitivity for automatic cueing and prolonged activity by processes similar to those associated with the intrusive memory.

Our second hypothesis was that occurrence of the intrusive image during suppression would be positively correlated with the number of intrusive images in the diary. This was indeed the case, with an extremely high correlation of .94. Occurrence of the intrusive image post-suppression was also significantly and positively correlated with the number of intrusive images in the diary (.57). This indicates that the extent to which the intrusive image remains active after suppression is related to naturally occurring intrusions. Perhaps the meaningfulness of the intrusive image is associated with higher accessibility (and thus higher activation) and/or lack of deliberate control. Interestingly, occurrence of the scene and control images during suppression were also highly correlated with the number of intrusive images in the diary (.74 and .64, respectively). This finding suggests that trait ability to suppress may be involved. Earlier studies indeed suggest that there are measurable individual differences in successful cognitive control strategies related to thought suppression (e.g., Williams, Moulds, Grisham, Gay, Lang, Kandris, et al., 2009). Of relevance to this interpretation, Verwoerd and colleagues (2008, 2009) showed that attentional control (especially resistance to pro-active interference) was negatively related to more intrusive images from a stressful film. At this stage, our interpretation is limited to speculation because no measure of trait suppression was included in our study.

Our study has several limitations. We used a laboratory stressor to induce intrusive images and our participants were all university students. This limits the generalization of our findings to the general population. Although our to-be-suppressed targets were assumed to be negative targets (based on data from our previous studies) we did not assess the valence or discreteness of the targets. Thus, we cannot confidently rule out moderation of affective properties in our findings. Finally, the image of drowning as a control negative image turned out to be an inelegant choice. Although we intended to control for the specific trauma film as a confounding factor, the image of drowning differs in more respects than initially foreseen. In particular, its self-generated nature limits our findings and future studies should explore self-generated versus other-generated effects of thought suppression.

In sum, our findings suggest that negative images are equally hard to suppress, irrespective of intrusive nature. The ability to suppress in general appears to be related to the frequency of persistent intrusive images as measured in our study with a diary. Furthermore, the prolonged activation of an intrusive image after its suppression was also related to the persistent intrusive images in the diary. This finding suggests that a specific feature of an intrusive image (perhaps goal-relevance) is related to persistent intrusive images in addition to a suppression ability trait. Despite methodological limitations, the present study is important as it the first to disentangle (1) the concept of "intrusion" into a target characteristic and occurrences in awareness due to thought suppression; and (2) the suppression of "*trauma-related thoughts*" by looking specifically at mental *images*. This distinction is clinically and conceptually relevant for understanding conditions such as PTSD. Future research should aim to replicate these findings and extend the design by including control measures of valence, discreteness and trait suppression.

Chapter 9

Experimental evidence for attentional bias in analogue trauma

This chapter is based on Krans, J., Reinecke, A., de Jong, P. J., Näring, G., & Becker, E. S. Experimental evidence for attentional bias in analogue trauma. *Manuscript submitted for publication.*

Abstract

The present study investigated whether exposure to threat-related pictures would induce an attentional bias for threat stimuli. Participants were shown threat or neutral pictures and completed a Rapid Serial Visual Presentation (RSVP) task. They were instructed to identify two targets in a stream of neutral pictures that included landscapes and buildings as the first target, and threat or neutral pictures as the second target. The results showed that previous exposure to threat pictures disrupted the processing of the first target when the second target in an RSVP string was a threat picture, and additionally increased identification accuracy of the second target when this was a familiar threat picture. These findings suggest an attentional bias of increased identification of *perceptually* similar threat stimuli, and a bias of interference of ongoing processing in the presence of *conceptually* similar (i.e., threat) stimuli. These findings support the notion of the cognitive model of post-traumatic stress disorder (Ehlers & Clark, 2000) that trauma representations are automatically activated by perceptually similar cues, and suggest that conceptually similar triggering may underlie the feeling of “current threat” in PTSD.

Introduction

Cognitive models of anxiety (e.g., Mathews & Mackintosh, 1998) propose that the emotional valence of a stimulus can be appraised automatically. Stimuli that have features associated with threat will receive attentional priority, and will inhibit competing stimuli. Following these models, emotional cues will be preferentially processed at the cost of other cues. In line with this, information processing theories of post-traumatic stress disorder (PTSD; Brewin, Dalgleish, & Joseph, 1996; Ehlers & Clark, 2000) suggest that trauma representations (e.g., a feeling of current threat, or intrusive experiences) are activated automatically by threat-related cues, sometimes without awareness of the specific trigger. Often, the triggers share perceptual features with the trauma representation (e.g., the face of a man in the bar may resemble the face of the rapist) but they may also generalize to other threat cues (e.g., the colour red for someone who was in a bloody car accident). It is plausible that an attentional bias for trauma-related stimuli underlies the automatic activation of trauma representations.

Preferential processing of environmental stimuli that bear a strong perceptual resemblance to a traumatic situation will enhance the probability that a trauma representation emerges in conscious awareness and may thus be responsible for the maintenance of intrusive re-experiencing symptoms over time (Michael & Ehlers, 2007). From such a perspective, an attentional bias for *perceptual* trauma-reminders might be critically involved in the occurrence and persistence of unwanted reminders. In a first attempt to test whether an attentional bias (proactive interference specifically) exists for perceptual trauma-related stimuli, Verwoerd, Wessel, de Jong and Nieuwenhuis (2009) showed participants an aversive film and participants reported their intrusions of the film in a one-week diary. Film viewing was immediately followed by a Rapid Serial Visual Presentation (RSVP) task. In an RSVP task participants are presented with a string of rapidly presented visual items, and are instructed to attend to two targets (T1 and T2) that stand out, for example, by a different background colour. In Verwoerd et al. (2009), the T1 was a freeze-frame taken from the aversive film, or a neutral image. Participants were instructed to identify whether the T2 (landscape or architecture) was tilted to the right or left. The results showed no difference between film images and neutral images in the accuracy of identification of the T2 (or proactive interference). The authors describe that this was likely due to a ceiling effect for the

RSVP task. On an individual level, however, proactive interference of film images on correctly identifying T2 was positively related to the number of intrusions. This relation was moderated by attentional control (the ability to shift / disengage attention, specifically). In a second study, a control group that did not view the aversive film was included to control for mere familiarity effects. A similar RSVP task was given to participants who viewed the aversive film and those who did not (Verwoerd, Wessel, & de Jong, in press). A similar interference was observed when T1 was a film target, but only in the group who previously viewed the film. This effect did not appear to stem from mere familiarity with the targets, as it did not appear for a neutral film.

The aforementioned studies support the role of attentional bias (proactive interference) in the automatic activation of trauma representations. However, several questions remain unanswered. First, it is unknown if such a bias would also generalize to other threat-cues, i.e., a generalization of triggers that activate trauma representations beyond perceptual similarity. Therefore, the present study included two groups: an analogue trauma group who viewed 'trauma' pictures before the RSVP task, and a neutral control group who viewed perceptually similar pictures in which the central threat object (e.g., a baby corpse) was replaced by a non-threatening object (e.g., a gold bar). Both groups additionally viewed four neutral pictures to control for mere familiarity effects. Second, to prevent any differences in a priori mood state between these groups, the RSVP task was started only when mood had returned to baseline. Third, the present study reversed the contents of the two targets: T1 was always neutral, whereas T2 included threat-related items. This way, interference with ongoing processing as described by the model of attentional bias in anxiety (Mathews & Mackintosh, 1998) is tested as an extension to the proactive interference studies by Verwoerd and colleagues (2009; in press). Interference of ongoing processing may be closer to reflect the disruption of ongoing activities by an encounter with a trauma or threat reminder, for example, in the startle reflex that is as is often reported in PTSD (American Psychiatric Association, 2000). Fourth, the first study by Verwoerd et al. (2009) observed ceiling effects for the RSVP task instruction (identifying whether T2 was tilted to the left or right). Therefore, we explicitly intended a more difficult AB task by asking participants to report both T1 and T2. This additionally ensures that participants indeed process the first target which is hard to control for when not asking for a T1 report. Finally, to ensure more control of the salience, valence and arousal of the RSVP items, pre-rated still pictures of the International Affective Picture System (Lang, Bradley, & Cuthbert, 2001) were used.

Based on the theory of attentional bias in anxiety (Mathews & Mackintosh, 1998), we expected the following: (1) T2 trauma pictures will benefit from enhanced identification compared to other T2 categories, (2) because highly salient T2 stimuli may interrupt processing of T1, presenting new threat pictures or trauma pictures as T2 will result in a lowered T1 identification in the trauma group compared to the neutral group. As indicated by Mathews & Mackintosh (1998), if during the processing of a neutral T1 a more important T2 is encountered, attention shifts from T1 to T2, resulting in the loss of T1 in the identification process. In the neutral group we expected (3) an enhanced identification of pictures from the induction phase compared to the other categories due to familiarity, and (4) we expected that correct identification of trauma pictures will be positively related to intrusion frequency in the trauma group.

Method

The present study was approved by the Ethical Committee of Behaviour Science Research of the Radboud University Nijmegen (ECG09032009).

Participants

Participants were university students (N = 81) who were randomly assigned to the trauma or neutral group. They were screened for panic attacks, panic disorder, PTSD, major depressive episode (current and lifetime), psychotic episode (current and lifetime), blood phobia and history of fainting, and were excluded from the study if any criterion was present. Participants received course credit for participation. The RSVP task was presented with Matlab software (Psychophysics Toolbox) other measures were presented with Inquisit 3 (Millisecond Software).

Materials

Anxiety and mood. The Dutch version of the State-Trait Anxiety Inventory (Zelfbeoordelingsvragenlijst; Van der Ploeg, 1980) was used to assess trait (STAI-T) and state anxiety (STAI-S). Negative mood was measured with the mood questionnaire as in

Holmes, Brewin, and Hennessy (2004). This questionnaire contains five single item ratings for current happiness, anxiety, horror, depressed mood, and anger. Scores were summed (happiness reversed).

Attention and attentional control. Attention for the pictures in the induction phase was rated on an 11-point scale from 0 (not at all) to 10 (completely). The Dutch version of the Attentional Control Scale (Derryberry & Reed, 2002; Verwoerd, de Jong, & Wessel, 2006) contains 20 items and consists of two subscales: Attentional Focus (9 items) and Attentional Shifting (11 items).

Induction. Pictures were presented with a light grey frame for 5 seconds on a computer screen, with 1 second in between pictures during which the screen was white. Both groups viewed the same four neutral pictures. Participants in the trauma group were then presented with four negative pictures. Participants in the neutral group viewed four neutral pictures that were matched to the trauma pictures except for the trauma content (e.g., the pre-matched IAPS nr. 3005.1 and 3005.2). Participants were instructed to view the pictures as if they were witnesses to the scene and not to mentally disengage from the pictures.

Intrusion provocation task. After the RSVP trials, participants in the trauma group were presented with blurred versions of the trauma pictures for 10s using Microsoft PowerPoint. Participants were instructed to think freely for two minutes while recording any intrusive images by pressing a key (registered with Microsoft Word). Key presses were summed to reflect intrusion frequency in the trauma group.

RSVP task. Forty neutral pictures (not presented in the induction phase) were used as distracter items. As T1 targets, 32 neutral pictures were selected. Half of these pictures depicted landscapes, the other half architectural scenes (Verwoerd et al., 2009). T2 items were the 4 trauma pictures (viewed by the trauma group), the 4 matched pictures (viewed by the neutral group), the 4 familiar-neutral pictures (viewed by both groups), 4 new-negative pictures, and 4 new-neutral pictures. To prevent salience effects (uncontrolled for by the IAPS ratings) and to promote conceptual threat categorization, all stimuli in the RSVP task were presented in sepia colour. Targets were presented with a bright grey frame, whereas distracters had a dark grey frame. Pictures were presented in a 19 cm x 19 cm size (Verwoerd et al., 2009).

Each trial started with the presentation of a centred black fixation cross for 500ms. Then, 15 pictures were presented in a row with a stimulus duration of 80 ms, without interstimulus interval. Participants were instructed to attend to the stream of pictures and to identify the two target pictures marked by a bright grey frame. A blank grey screen appeared for 1000 ms to prevent memory masking. Then, two response menus were presented for 5000 ms maximum. The first asked for T2 identification whereas the second asked for T1 identification (Reinecke, Rinck, & Becker, 2008). The central feature of every T2 picture was identified beforehand by three raters on the basis of consensus. The response menu for T2 consisted of a comparison of the central feature of two pictures. For example, "Was it a baby or a fire?" One response option was the central feature of the presented T2, whereas the other option was a central feature of any other T2 picture. T2 depicted each of the five possible picture categories (trauma, matched, new-negative, new-neutral, familiar-neutral) equally often. For T1, participants had to indicate whether it depicted a landscape or architecture (Verwoerd et al., 2009). Landscape vs. architecture items were each displayed 50% of the time. Guessing was explicitly discouraged and a forced-choice format was used. Participants started a new trial through button press and could therefore pace their breaks. Trial by trial, the position of T1 within the picture series was randomly determined, occurring in equal frequency at the string positions 3 to 9. T2 appeared with a lag of 1, 2 or 6 after T1. For example, lag 2 indicates that T2 is presented as the second item appearing after T1. The remaining 13 positions within the picture string were randomly filled with distracter items. Subjects worked on 6 practice trials and 360 experimental trials, consisting of 2 (repetitions) x 2 (T1 categories) x 5 (T2 categories) x 3 (lag) x 6 (T1 string positions). The mean accuracy in correctly identifying T2/T1 provided that the T1/T2 response was accurate was calculated per T2 category/lag combination.

Procedure

After screening and signing an informed consent form, participants filled in the STAI-T, STAI-S and the mood questionnaire. Next, participants viewed the pictures according to experimental condition, followed by the STAI-S and the mood questionnaire. To ensure mood would return to baseline levels, participants then worked on a word finding puzzle for ten minutes. Afterwards, the STAI-S and mood questionnaire were administered and checked to reflect baseline emotional state. If a participant showed elevated scores, the distraction task was extended by five minutes and STAI-S and the mood questionnaire were administered again. Next, participants worked on the RSVP task and participants in the trauma group performed the intrusion provocation task (Lang, Moulds, & Holmes, 2009).

Results

Statistical approach

All variables were checked on outliers across and within groups. There were no multivariate outliers as indicated by Mahalanobis distances. There were four univariate outliers which were adjusted according to the procedure described by Tabachnick and Fidell (1996). Two participants indicated low attention (score 2 and 5) for the pictures in the induction phase and were therefore excluded from analysis. Differences between groups and target categories were tested with repeated-measures ANOVAs and follow-up independent- or paired-samples t-tests. Reported results for experimental effects are corrected for pre-experimental differences between the groups (trait anxiety, baseline mood, and attention) by including these variables as covariates in ANOVA analysis. All tests were done with an alpha of .05. Self-report data are reported in Table 1, experimental data in Table 2.

Control measures

Groups were comparable on age, $t(77) = 1.29$, $p = .20$, with $M = 20.29$, $SD = 1.86$; educational level, $\chi^2(2) = 2.00$, $p = .37$, with 89.9% university, 7.6% college, and 2.5% lower education; overall attentional control (ACS), $t(77) = 0.19$, $p = .85$, Attentional Focusing, $t(77) = 1.12$, $p = .27$, and Attentional Shifting, $t(77) = 0.64$, $p = .52$; and state anxiety (STAI-S) at baseline, $t(77) = 1.39$; $p = .17$.

The neutral group showed a trend towards more negative mood at baseline compared to the trauma group, $t(77) = 1.86$, $p = .07$. Trait anxiety (STAI-T) was significantly higher in the neutral group than in the trauma group, corrected $t(67.80) = 2.08$, $p = .04$. Participants in the trauma group reported more attention for pictures in the induction phase than participants in the neutral group, $t(77) = 2.28$, $p = .03$.

Manipulation check

Emotional impact of induction. A 2 Group (neutral, trauma) x 2 Time (baseline, post-induction) repeated measures ANOVA was performed, with negative mood as the dependent variable. There was a significant main effect of Time, $F(1, 77) = 52.71$, $p < .001$, $f = 0.83$; and Group, $F(1, 77) = 13.48$, $p < .001$, $f = .42$, and a significant Group x Time interaction effect, $F(1, 77) = 56.50$, $p < .001$, $f = 0.85$. In the neutral group, there was no significant change in negative mood from baseline to post-induction, $t(39) = 0.40$, $p = .69$. Negative mood increased significantly from baseline to post-induction in the trauma group, $t(38) = 7.71$, $p < .001$, $d = 0.83$, and post-induction scores were significantly higher than in the neutral group, corrected $t(50.83) = 5.79$, $p < .001$, $d = 1.41$.

The impact on state anxiety was tested with a 2 *Group* (neutral, trauma) x 2 *Time* (baseline, post-induction) repeated measures ANOVA. There was a significant main effect of *Time*, $F(1, 77) = 22.83$, $p < .001$, $f = 0.55$; but not of *Group*, $F(1, 77) = 0.34$, $p = .56$, and a significant *Group x Time* interaction effect, $F(1, 77) = 15.20$, $p < .001$, $f = 0.44$. In the neutral group, there was no significant change in state anxiety from baseline to post-induction, $t(39) = 0.63$, $p = .53$. There was a significant increase in state anxiety from baseline to post-induction in the trauma group, $t(38) = 6.08$, $p < .001$, $d = 0.91$. Post-induction state anxiety was marginally significantly higher in the trauma group than in the neutral group, $t(77) = 1.89$, $p = .06$, $d = 0.43$.

Return to baseline. To test whether mood returned to baseline levels after the distracter task, a 2 Group (neutral, trauma) x 2 Time (baseline, post-distracter) repeated measures ANOVA was performed, with negative mood as the dependent variable. There was no significant main effect of Group, $F(1, 77) = 0.73$, $p = .40$, but a significant main effect of Time, $F(1, 77) = 11.36$, $p < .01$, $f = 0.38$, and a Group x Time interaction effect, $F(1, 77) = 8.79$, $p < .01$, $f = 0.34$. The neutral group indicated significantly higher negative mood at baseline than post-distracter, $t(39) = 5.19$, $p < .001$, $d = 0.30$. Negative mood at baseline was comparable to post-distracter mood in the trauma group, $t(38) = 0.26$, $p = .80$. Post-distracter, there was no significant difference in negative mood between the groups, $t(77) = 0.60$, $p = .55$.

Table 1. *Self-report data within and across conditions*

		Neutral group		*Trauma group*		*Total*	
Measure		*M*	*SD*	*M*	*SD*	*M*	*SD*
ACS		54.38	7.69	54.05	7.37	54.22	7.49
STAI-T		36.93	7.31	34.03	4.83	35.49	6.34
Mood	baseline	6.88	3.74	5.38	3.35	6.14	3.61
	post induction	6.70	3.68	15.46	8.73	11.03	7.96
	post distracter	4.88	2.85	5.26	2.80	5.06	2.81
STAI-S	baseline	32.08	5.77	30.49	4.29	31.29	5.12
	post induction	32.60	7.39	65.67	7.05	34.11	7.34
	post distracter	30.15	5.89	31.10	4.74	30.62	5.34
Attention		8.25	0.98	8.82	1.23	8.53	1.14
Intrusions		-	-	12.13	11.56	-	-

A 2 *Group* (neutral, trauma) x 2 *Time* (baseline, post-distracter) repeated measures ANOVA with state anxiety (STAI-S) as the dependent variable showed the same pattern for state anxiety: main effects of *Group, p* = .77; *Time, p* = .12; *Group x Time* interaction, $F(1, 77) = 9.12$, $p < .01$, $f = 0.34$. In the neutral group, there was a significant decrease in state anxiety from baseline to post-distracter, $t(39) = 3.10$, $p < .01$, $d = 0.33$. In the trauma group, there was no significant difference between baseline and post-distracter state anxiety, $t(38) = 1.09$, $p = .28$. Groups were comparable on state anxiety after the distracter task, $t(77) = 0.79$, $p = .43$.

Experimental effects

T2 accuracy for correct T1 trials. A three-way repeated measures ANOVA was run, including the between-subjects factors *Group* (neutral, trauma), the within-subjects factors *Picture* (trauma [Trauma], matched [Matched], familiar-neutral [FN], new-negative [NNeg], new-neutral [NNeut]), and *Lag* (1, 2, 6). The dependent variable was the accuracy rate in reporting T2 in correctly identified T1 trials. There was no significant main effect of lag, *F*(2,

148) = 1.16, p = .32, nor did any of the interactions including this factor reach statistical significance, all F(2, 148/8, 592) < 2.63, all ps > .08. Therefore, data were collapsed over lags for further analysis. There was a significant main effect of *Picture*, F(4, 296) = 3.07, p = .02, f = 0.20, and a significant *Picture x Group* interaction, F(4, 296) = 2.47, p = .05, f = 0.18. In both groups, report accuracy was higher for NNeut pictures compared to all other picture types: trauma group all t(38) > 4.88, all p < .001, all d > .91; neutral group all t(39) > 5.72, all p < .001, all d > 1.08. This suggests that, despite pilot testing and using sepia colour, NNeut pictures appeared to be more salient. Participants in the trauma group identified Trauma pictures significantly more accurately than pictures from the remaining three types (NNeg, Matched, FN), all relevant t(38) > 2.26, all p < .03, all d > .46, but did not show any further differences, all relevant t(38) < 0.78, all p > .44. Participants in the neutral group reported FN pictures more accurately than NNeg pictures, t(39) = 2.06, p < .05, d = .38, and showed a non-significant trend in reporting these FN pictures more accurately than Trauma pictures, t(39) = 2.01, p = .051, d = .31, all other t(39) < 1.39, all p > .17. The two groups differed only with regard to Trauma pictures, with higher accuracy in the trauma group, F(1, 74) = 5.66, p = .02, f = 0.27.

Table 2. *Means and standard deviations for the RSVP effects. Upper panel: T2 report accuracy in T1-correct trials. Lower panel: T1 report accuracy in T2-correct trials (lower panel)*

		Trauma group			*Neutral group*		
Picture Category		*lag 1*	*lag 2*	*lag 6*	*lag 1*	*lag 2*	*lag 6*
T2	Trauma	.70	.73	.71	.62	.61	.61
		(.15)	(.17)	(.17)	(.21)	(.19)	(.18)
	Matched	.64	.65	.70	.63	.64	.64
		(.17)	(.15)	(.14)	(.14)	(.17)	(.17)
	New-Negative (NNeg)	.65	.64	.66	.63	.60	.61
		(.18)	(.16)	(.18)	(.17)	(.17)	(.18)
	New-Neutral (NNeut)	.83	.81	.80	.79	.79	.75
		(.10)	(.14)	(.14)	(.12)	(.13)	(.14)
	Familiar-Neutral (FN)	.65	.65	.65	.70	.67	.63
		(.16)	(.18)	(.17)	(.13)	(.14)	(.16)
T1	Trauma	.50	.52	.55	.56	.53	.51
		(.13)	(.11)	(.13)	(.14)	(.15)	(.16)
	Matched	.53	.49	.57	.49	.52	.53
		(.15)	(.12)	(.14)	(.14)	(.11)	(.14)
	New-Negative (NNeg)	.50	.54	.55	.56	.49	.54
		(.14)	(.14)	(.13)	(.14)	(.13)	(.13)
	New-Neutral (NNeut)	.56	.55	.55	.49	.56	.52
		(.11)	(.13)	(.13)	(.09)	(.12)	(.13)
	Familiar-Neutral (FN)	.54	.55	.55	.51	.55	.53
		(.14)	(.14)	(.14)	(.13)	(.14)	(.12)

T1 accuracy for correct T2 trials. A repeated-measures ANOVA with the factors *Group* (neutral, trauma), *Picture* (Trauma, Matched, FN, NNeg, NNeut), and *Lag* (1, 2, 6) was run. The dependent measure was the accuracy in identifying T1 in correct T2 trials. None of the main effects nor two-way interactions reached statistical significance, all $F(1, 74/2, 148/4, 296/8, 592) < 1.60$, all $ps > .18$. The three-way interaction was significant, $F(8, 592) = 3.04$, $p < .01$, $f = 0.20$, and additional *Lag x Group* two-way ANOVAs were run for each picture type. The two factors significantly interacted for Trauma pictures, $F(2, 148) = 3.23$, p

= .04, f = 0.20; and NNeg pictures, $F(2, 148) = 4.15$, $p = .02$, $f = 0.23$. One-way ANOVAs showed a significantly reduced accuracy for T1 pictures in a Trauma trial in the trauma group compared to the neutral group at Lag 1, $F(1, 74) = 9.47$, $p < .01$, $f = .35$; but not at Lag 2 (p = .67) or Lag 6 (p = .63). Accuracy for T1 pictures in a NNeg trial was similarly reduced in the trauma group compared to the neutral group at Lag 1, $F(1, 74) = 4.88$, $p = .03$, $f = .25$; but not at Lag 2 (p = .13) or Lag 6 (p = .83).

Correlations of RSVP parameters. In the trauma group, higher accuracy for Trauma T2 (collapsed across lags) was significantly related to higher overall attentional control (ACS), $r = .35$, $p = .03$, which appeared to be driven by the Attentional Shifting subscale, r = .44, $p < .01$. The Attentional Focus subscale was not significantly correlated with Trauma accuracy, $r = .18$, $p = .28$. There was a non-significant trend between accuracy for NNeg T2 and Attentional Shifting, $r = .29$, $p = .07$. Matched, NNeut, and FN T2 were not related to any of the self-report measures, all $r < |.20|$, all $ps > .21$. In the neutral group, none of the correlations reached statistical significance, all $r < |.18|$, all $ps > .28$.

Intrusive images. There were no significant correlations with any parameters for intrusion frequency measured in the trauma group with the intrusion provocation task, all $r_s <$ .23, all $ps > .16$.

Discussion

The present study aimed to experimentally test whether analogue trauma would give rise to priority processing of trauma reminders. The major results can be summarized as follows: (i) exposure to negative pictures increased identification of these pictures in an RSVP task; (ii) this preferential processing was at the expense of correctly identifying a neutral previous target (i.e., T1); (iii) exposure to negative pictures resulted in a hampered identification of the T1 when the T2 was a new negative picture, indicating a generalization of threat triggers without enhanced identification of the trigger; and (iv) these effects were not due to mere familiarity.

Enhanced identification of trauma reminders

The first hypothesis was confirmed by the data. Participants in the trauma group showed a higher accuracy for the Trauma pictures from the induction phase compared to the neutral group. This finding supports an attentional bias of *enhanced identification for perceptually similar stimuli* induced by analogue trauma. There was no enhanced identification of the New Negative pictures. Thus, the bias did not generalize to threat stimuli that were not perceptually similar. This is in line with the cognitive model PTSD (Ehlers & Clark, 2000) stating that trauma representations are automatically activated on encounter with perceptually similar cues in the environment. This particular bias may function as a 'warning signal' for a potentially dangerous situation (e.g., Ehlers, Hackmann, Steil, Clohessy, Wenninger, & Winter, 2002; Krans, Näring, Becker, & Holmes, 2009).

Interestingly, attentional shifting (ACS) was positively correlated with identification of Trauma and New Negative pictures in the trauma group. This suggests that the ability to shift attention may enhance an attentional bias for threat stimuli in the form of interference of ongoing processing. Whereas relevant trauma-related stimuli may already receive preferential processing, this enhancement may be exaggerated by a trait factor of shifting attention easily to other relevant stimuli.

Trauma induced interference of neutral T1 identification

In line with the hypothesis, higher accuracy of the Trauma pictures in the trauma group was associated with a disruption of ongoing processing as suggested by a decreased accuracy for T1 targets in Trauma trials. This finding is in line with earlier studies (Verwoerd et al., 2009; Verwoerd et al., in press) that showed a trauma-related interference. The results support the model of attentional bias in anxiety (Mathews & Mackintosh, 1998) as a threat-related stimulus was preferentially processed over a neutral stimulus. Whereas participants in the trauma group did not show an increased accuracy for New Negative pictures, the appearance of a New Negative target did disrupt processing of the neutral T1 target. This finding indicates an *attentional bias that disrupts ongoing processing in the presence of a conceptually relevant stimulus* (i.e., a threat picture that is not perceptually similar to the Trauma pictures). As this disruption did not lead to enhanced identification of the threat stimulus (as was the case for perceptually similar threat cues) the person may not be able to tell the cause of the disruption. This post hoc explanation is in line with the observation that trauma representations can be activated automatically without conscious awareness of the trigger (e.g., Ehlers & Clark, 2000; Brewin et al., 1996). The (analogue) trauma-related information from the induction phase was indeed activated as suggested by the disruption of T1 processing in New Negative trials in the trauma group, but did not lead to enhanced identification of the T2. The findings cannot be ascribed to mere familiarity effects, as the Familiar Neutral pictures did not lead to higher identification in the trauma group. This suggests that the (analogue) trauma representation was activated without identification of the target in some trials. This finding fits with the understudied concept of "current threat" in PTSD (Ehlers & Clark, 2000). Because the threat stimulus does not share perceptual features with the trauma memory in this case, perhaps only the shared feature (i.e., threat!) of the trauma representation is activated. The activation of a feeling of threat without the identification of the trigger is then experienced as a feeling of current threat. It would be interesting for future research to explore what information of a trauma representation is activated depending on the features that are shared with the trauma stimulus in the environment (i.e., visual, olfactory, emotional, etc.).

In line with our hypothesis, the neutral group showed a familiarity effect (although not for the matched pictures) as suggested by a higher accuracy for the Neutral Familiar pictures compared to the Trauma pictures and the New Negative pictures. This finding underlines the importance of previous exposure to threat stimuli in the attentional bias in our study.

Intrusion frequency and attentional bias

In contrast to our hypothesis, we did not find any correlations with intrusion frequency. This is likely to be an effect of our design: intrusive images were measured directly after the RSVP task, whereas previous studies used a one-week diary. Thus, we measured intrusions during the consolidation phase (supported by the high number of intrusions during this task) whereas effects are usually found after consolidation. It would therefore be interesting in future research to explore the time frame in which the relation between attentional bias and intrusion frequency is established.

Limitations

Our study has several limitations. First, we used a laboratory stressor in a student population as an "analogue trauma" exposure to negative stimuli. It therefore remains to be tested whether similar processes are involved in actual trauma. Future research may benefit from replication of this study in PTSD patients. Second, we did not find a lag effect for T2 accuracy, which is usually found in so-called "attentional blink" studies. In these studies, identification of neutral T2 is typically hampered when T2 follows T1 within 100-500 msec, due to the unfinished processing of T1 (Chun & Potter, 1995). Possibly, the familiarity with 40% of the T2 targets and the emotionality in 40% of the targets may have washed out an attentional blink effect. Another limitation may be the order of RSVP response menus (T2 then T1). The sequence could have interfered with the continued activation of the T1 identity in working memory, resulting in artificially attenuated identification of T1. However, this procedure cannot explain T2 specific effects between and within groups and therefore does not seem to qualify the main outcomes of this study.

Conclusions

The present study suggests that exposure to analogue trauma gives rise to two types of attentional bias. First, there appears to be an *increased identification of perceptually similar* trauma stimuli, supported by enhanced identification of Trauma pictures but not New Negative pictures in the trauma group. Second, there is an *interference of ongoing processing in the presence of conceptually similar* (i.e., threat) *stimuli*, supported by a hampered T1 identification in both Trauma and New Negative trials in the trauma group. Individual differences in the ability to shift attention to relevant cues play a role in this relationship. The enhanced identification of Trauma in pictures combined with lower identification of the T1 supports the attentional bias model of anxiety (Mathews & Mackintosh, 1998). The finding that ongoing processing can be disrupted in the absence of enhanced identification of the "disruptor" extends the model. The findings support the cognitive model of PTSD (Ehlers & Clark, 2000) in that trauma representations in memory are automatically activated by relevant (threat) cues, and trauma representations can be activated without enhanced identification of the trigger. Future research has to point out whether this mechanism underlies the important central feature of current threat in trauma-exposed individuals.

Chapter 10

Intrusive trauma memory: A review and functional analysis

This chapter is based on Krans, J., Näring, G., Becker, E. S., & Holmes, E. A. (2009). Intrusive trauma memory: A review and functional analysis. *Applied Cognitive Psychology, 23*(8), 1076-1088.

Abstract

The present chapter focuses on a functional analysis of the phenomenon of intrusive trauma memory. While intrusive trauma memories undoubtedly cause impairment, we argue that they may exist for a potentially functional reason. Theory and experimental research on intrusion development are reviewed and possible functions of intrusive trauma memory are explored. These functions include facilitating emotional processing, preventing future harm, and protecting the coherence of the self. The issue of intrusive images in other disorders than post-traumatic stress disorder is addressed. This review suggests that the study of function is important for a nuanced view on the modulation of intrusive trauma memory in both experimental psychopathology and clinical treatment.

What is intrusive trauma memory?

Our lives are full of experiences and events that have a lasting impact on us. Many of these are expected or planned for like going to college, getting married, starting a family, and the passing away of our parents. Such momentous events (Pillemer, 1988) can be negative, positive, or both, but we are usually able to cope with them. Some events, however, have such an impact that our adaptive skills may fail and we become 'traumatized'. One consequence of traumatic events (like other momentous events, at least initially) is the subsequent unwanted re-experiencing in the form of intrusive memories. Although it is undoubtedly crucial to investigate ways to reduce these unwanted memories, the main question raised in this paper is: "Why would we have intrusive trauma memories at all?" This question is inspired by Baddeley (1988), who argued not only to look at underlying basic mechanisms of cognitive phenomena, but also to try and understand what functions they may serve. Especially in literature on psychopathology, the main interest has been to reduce intrusive trauma memories. But why would we have intrusive trauma memories at all? What is their function? And what do we lose when we succeed in reducing intrusive trauma memories without taking into account possible adaptive functions? As Baddeley (1988) suggested, whenever we find a really replicable memory phenomenon, we should ask ourselves what its function may be. The current paper presents a review of the theory and experimental findings followed by an exploration of potential functions of intrusive trauma memory.

Intrusive trauma memory

Intrusive trauma memories are rich multi-modal mental images of highly detailed sensory impressions of the traumatic event including sights, sounds, feelings and bodily sensations. Examples of intrusive trauma memories are seeing the driver's face before a car crash (Lilley, Andrade, Turpin, Sabin-Farrell, & Holmes, in press), an image of "brother with head [cut] open, wobbling" (Holmes, Grey, & Young, 2005), or the sound of a child screaming (Holmes et al., 2005). In contrast to when a trauma survivor thinks back to the event deliberately, intrusive trauma memories come into consciousness unbidden. Often, people feel powerless against them. In order to understand intrusive trauma memories, models have been developed that specifically focus on full-blown post-traumatic stress disorder, i.e., PTSD (Brewin, Dalgleish, & Joseph, 1996; Ehlers & Clark, 2000; Brewin & Holmes, 2003).

However, it has long been argued (Horowitz, 1969) that the underlying mechanisms that are involved in the development of intrusive trauma memories are similar for both psychiatric levels and sub-threshold levels of post-traumatic stress. For example, Holmes (2004) illustrated that the features of intrusive images may be similar for experiencing actual trauma, witnessing trauma and seeing a TV news report about a traumatic event such as September 11^{th} 2001 (Holmes, Creswell, & O'Connor, 2007). Mace (2007) has proposed that intrusive memories are found in everyday mental life and as part of psychological disorders as well. Accordingly, intrusive trauma memories may vary from mildly distressing images to full-blown flashbacks where the trauma survivor is completely absorbed in the memory and temporarily loses touch with the here-and-now. In terms of functionality, intrusive trauma memories may have features that are not necessarily shared with non-traumatic involuntary recall. For example, the content of intrusive trauma memories does not seem to change very much and can persist to intrude over a long period of time. These memories are cue-activated automatically which can make intrusion relatively frequent.

Trauma and Post-traumatic Stress Disorder (PTSD)

Examples of events meeting the clinical criteria for “trauma” are natural disasters, interpersonal violence and torture, and road traffic accidents. These events are considered ‘traumatic’ if the person experiences or witnesses actual or threatened death, serious injury or threat to one’s or others’ integrity (American Psychiatric Association, 2000). The person also needs to experience an intense negative emotional reaction at the time of trauma. For example, a soldier may witness a death but not experience intense fear, or horror, or helplessness. Then, the event would not count as traumatic. In reaction to trauma, several typical symptoms can emerge that are important in the diagnosis of PTSD (APA, 2000). These include re-experiencing of the traumatic event (e.g., in the form of intrusive trauma memories, nightmares and distress in reaction to trauma reminders), avoidance behaviour related to the index trauma (e.g., avoiding conversations, places and objects, and a general emotional numbing response) and symptoms of hyperarousal (e.g., startle response, sleeping problems, hypervigilance). The diagnosis of PTSD is considered when these symptoms persist for more than one month and cause significant impairment in various life domains (APA, 2000).

Post-traumatic stress is an important area of research because of the high lifetime risk of experiencing a traumatic event. Some studies have found lifetime risks as high as 89.6 % (Breslau et al., 1998). However, only a small proportion of trauma survivors subsequently develop full blown PTSD. Kessler, Sonnega, Bromet, Hughes, and Nelson (1995) estimated the lifetime prevalence of PTSD at 7.8% in an American sample, while Creamer, Burgess and McFarlane (2001) found a 12-month prevalence of 1.3% in an Australian sample. Some types of trauma are more likely to elicit PTSD than others. Generally, rape and physical abuse pose a high risk for PTSD, while people seem less at risk after traffic accidents or natural disasters. Kessler et al. (1995) found PTSD rates for rape victims of 65% for men and 46% for women, and 22% for men and 49% for women in cases of physical abuse. Creamer et al. (2001) reported a similar pattern. In contrast, PTSD prevalence rates after traffic accidents of 6.3% for men and 8.8% for women, and of 3.7% for men and 5.4% for women after natural disasters have been reported (Kessler et al., 1995). In sum, intentional harm seems to be more likely to produce post-traumatic stress symptoms. This finding may provide a clue as to the function of intrusive trauma memories. For example, events involving human violence may be perceived as more under our control (and thus that we have lost control) than, for example, an earthquake. Intrusive trauma memories of human violence may provide information that can prevent from future harm (see our discussion on warning signals later on).

While a traumatic event is necessarily the starting point of PTSD symptoms, it is obviously not a sufficient explanation. Interestingly, the risk factors with the greatest predictive power for PTSD appear to be psychological. More recent meta-analyses indicate that information processing during and after the traumatic event is critical (Brewin, 2003; Ozer, Best, Lipsey, & Weiss, 2003). We now review three theoretical models that explain intrusive trauma memories from an information processing perspective. The first model is not specific for PTSD but provides an account of intrusive trauma memories based on a model of autobiographical memory in general, in line with our continuum view. The second and third models aim to explain the full range of PTSD symptoms, including intrusive memories, from a clinical perspective. They have proven very fruitful in the development of successful PTSD treatment and have sparked a bulk of experimental research that is also very important from a continuum perspective.

Cognitive models of PTSD

The Self-Memory-System (SMS) model of autobiographical memory (Conway & Pleydell-Pearce, 2000; Conway, Singer, & Tagini, 2004) suggests that intrusive trauma memories are encoded in the episodic memory system as episodic memories. These memories are detailed "experience-near" records that are high in sensory-perceptual detail. What is encoded (in general and during a traumatic event) is determined by the "working self". The "working self" is a complex goal hierarchy that organizes information in line with currently active goals, comparable to the central executive function in working memory (Conway et al., 2004; Baddeley & Hitch, 1994). Episodic memories remain in their characteristic form while the goal they reflect is still active or relevant. They are activated by cues that bare perceptual similarities with the memory. If not lost, episodic memories are slowly integrated with more abstract levels of autobiographical knowledge, which prohibits cued-activation (i.e., unwanted intrusion) of the specific episodic memory. The more abstract levels of autobiographical knowledge form the "long-term self" that encompasses an autobiographical knowledge base and a "conceptual self". The first is an organization of autobiographical information in different levels of abstraction into themes or time-periods (i.e., general events, life-time periods, and life story schema). The conceptual self contains schemas, scripts, beliefs, and values about the self, others, the world, and the relations between them. Thus, the integration of episodic memories into more abstract goal structures consists of changes in these structures. As a basic rule, the goal structures in the SMS are resistant to extreme goal change and only allow for gradual change in order to protect self-coherence (Conway et al., 2004). A traumatic event, by definition, poses a direct and extreme threat to the goal structure of the SMS. As a consequence, the traumatic event remains an intrusive episodic memory that is high in sensory detail. In contrast to clinical models of PTSD, described below, the SMS model (Conway & Pleydell-Pearce, 2000; Conway et al., 2004) does not assume qualitatively different mechanisms for traumatic memories, but rather states that traumatic information may have more "difficulties" along the way to become a "normal" autobiographical memory.

The dual representation theory (DRT) by Brewin, Dalgleish and Joseph (1996) suggests that traumatic information is encoded in two different memory systems: Situationally Accessible Memory (SAM) and Verbally Accessible Memory (VAM). SAMs are perceptual memories that are automatically triggered by internal or external cues that match sensory perceptual features (i.e., intrusive trauma memories). In contrast, VAMs are the result of conscious processing of the traumatic event and they can be retrieved deliberately and consciously. Ideally, SAMs are integrated with VAMs to form a coherent and elaborate trauma narrative. Under extreme stress, however, the conscious processing that leads to VAMs is impaired (Brewin et al., 1996). As a result, there is relatively more trauma information encoded in the SAM system and very little in the VAM system. Intrusive trauma memories occur now because the cued-activation of SAMs is not inhibited by VAMs.

The cognitive model of PTSD by Ehlers and Clark (2000) provides the basis of their highly successful cognitive therapy treatment for PTSD (Ehlers, Clark, Hackmann, McManus, & Fennell, 2005). In this model, ‘data-driven’ processing predominates during a traumatic event while ‘conceptual’ processing is impaired. Data-driven processing involves sensory information like sight, smell, touch, sounds and bodily sensations. In contrast, conceptual processing of the traumatic event places the traumatic information in a more abstract form by creating a coherent trauma narrative that is chronological and meaningful. A central concept in the cognitive model of PTSD is a ‘sense of *current* threat’ that people experience when having an intrusive trauma memory. The sense of current threat exists due to a lack of chronological context in trauma memory so that the threat in the past is not distinguished from the present situation.

Discussion about the differences between PTSD specific theories (e.g., Brewin et al., 1996; Ehlers & Clark, 2000) and more general models of autobiographical memory (e.g., Conway & Pleydell-Pearce, 2000) has long historical roots (Horowitz, 1969; Rubin, Boals, & Berntsen, 2008). The SMS model (Conway & Pleydell-Pearce, 2000; Conway et al., 2004) aims to provide a holistic view on autobiographical memory and many of its phenomena and “touches on” intrusive trauma memory as well. Just as all goal-relevant information, traumatic information is encoded into an episodic memory system. However, the trauma information is not easily integrated in the autobiographical knowledge base because this would require extreme changes in the goal structures. Therefore, traumatic information remains at this highly perceptual level prone to automatic cued-activation, i.e., intrusive memories. In contrast, the DRT (Brewin et al., 1996) suggests *differential encoding* of trauma information into SAMs and VAMs. The cognitive model of PTSD by Ehlers and Clark (2000) contains some parallels to the SMS model and suggests that (trauma) information is encoded as episodic memories. Additionally, the model suggests a role for peri-traumatic processing (data-driven versus conceptual) that is not described in the SMS model. What becomes clear from all three models is that information processing and encoding are thought to play an important role in intrusion development. Many experimental studies of intrusive trauma memory have been carried out, which permits and calls for a functional analysis of this phenomenon (Baddeley, 1988).

Studying trauma in the laboratory

Support for the role of peri-traumatic processing in intrusion development comes from experimental studies that have made use of the 'trauma film paradigm' (Holmes & Bourne, 2008). A 'trauma film' refers to a film that depicts an event that is considered as traumatic according to the DSM-IV-TR (Criterion A1; APA, 2000). Typically, healthy participants view a trauma film under one of several controlled conditions. Before and after film viewing, questionnaires are administered to measure variables of interest. During the week after film viewing, participants record their intrusive images of the film in a diary and return for a follow-up session. In support of the utility of this paradigm, it has been found that intrusive memories elicited in a laboratory environment are in many respects similar to naturalistic intrusive memories (Schlagman & Kvavilashvili, 2008).

In order to manipulate information processing during encoding, participants can perform a concurrent task during film viewing. Using this dual-task approach, manipulations can be tailored to compete for specific resources, for example, for perceptual or verbal processing of the film (Holmes & Bourne, 2008). In a study by Stuart, Holmes and Brewin (2006), participants viewed a trauma film while modelling plasticine shapes as a dual task during one part of the film. During the rest of the film, participants performed no extra task apart from film viewing. The modelling clay task is thought to rely on limited resources of visual and spatial information processing which would interfere with visuospatial encoding of the film and thus reduce intrusion frequency. As predicted, participants reported fewer intrusive images after one week for the film part during which they were performing the visuospatial task compared to the film part during which they performed no extra task. This effect has also been shown for other visuospatial tasks, like complex pattern tapping (e.g., Holmes, Brewin, & Hennessy, 2004) and was upheld when contrasted with a non-visuospatial task with a comparable cognitive load (Krans, Näring, Holmes, & Becker, 2010). The findings support a facilitating role of peri-traumatic perceptual processing in intrusion development.

Findings pertaining to the role of peri-traumatic verbal conceptual processing are more mixed. Holmes et al. (2004; Experiment 3) found that participants who were counting backwards in 3's while viewing a trauma film reported *more* intrusive images of the film compared to participants who performed no extra task. This supports the DRT (Brewin et al., 1996) and the cognitive model of PTSD (Ehlers & Clark, 2000) in that interfering with verbal conceptual processing is thought to *increase* intrusion frequency. Bourne, Frasquilho, Roth, & Holmes (submitted) recently replicated this finding with a variation on the counting backwards task. However, Krans, Näring and Becker (2009) found the opposite effect: Participants who were counting backwards in 3's reported *fewer* intrusive images compared to participants in a no task control condition. Pearson, Sawyer and Holmes (2008) found a similar pattern of results. In two experiments, they varied the cognitive load of concurrent verbal or visuospatial tasks and found that intrusion frequency varied according to the cognitive load of the task (with higher cognitive load tasks reducing intrusion frequency) irrespective of task modality. However, Pearson et al. (2008) used static IAPS pictures instead of a trauma film, which makes comparison with earlier findings difficult. Studies that fail to show a modality-specific effect are in line with single-representation models of autobiographical memory like the SMS model (Conway & Pleydell-Pearce, 2000). In this model, cognitive load would reduce the capacity of the working self to guide and direct the encoding of the trauma film. Initial support for the SMS model (Conway & Pleydell-Pearce, 2000) comes from a study by Sutherland and Bryant (2008). As traumatic events pose a threat to the self, a discrepancy between an ideal and actual self emerges. This discrepancy creates goals that are represented in the working self in order to reduce the threat posed by the trauma (Conway & Pleydell-Pearce, 2000; Conway et al., 2004). As the working self modulates retrieval it was expected that threat-related memories are more easily recalled in case of trauma. Indeed, Sutherland and Bryant (2008) found that trauma survivors who reported more discrepancy between an ideal and actual self on a questionnaire also reported more trauma-related memories in response to positive cue words.

Krans, Näring, Holmes and Becker (2009a) used the trauma film paradigm to study analogue post-trauma processing. Immediately after film viewing participants received a memory test for only one part of the film. As predicted, one week later, participants reported *fewer* intrusive images for the film part for which they did the memory test compared to the part for which they had not done a test. Additionally, deliberate cued-recall after one week was *better* for the film part that was tested the week before. These results indicate that the rehearsal of analogue trauma information decreases intrusions and increases deliberate cued-recall (see also Holmes, James, Coode-Bate, & Deeprose, 2009).

In sum, several studies have shown that visuospatial processing of trauma information is an ingredient in the formation of intrusive trauma memories (e.g., Holmes et al., 2004). Further, the conceptual integration of trauma information may prohibit this development (Krans et al., 2009). In turn, the idea that sensory information may be more important in aiding survival *during* a traumatic event than elaborate conceptual processing is intuitive. Thus, the ‘heightened’ sensory information processing that is thought to later result in distressing intrusive trauma memories may be viewed as adaptive at the time. Thus, we know a little about how intrusive trauma memories come into existence but we really do not know why.

But what the hell is it for?

The question posed in the header has historical roots starting in the late ’70s and ’80s (e.g., Neisser, 1978; Bruce, 1989; Baddeley, 1988). More recently, several researchers have further encouraged students of memory to think about function in addition to mechanism (e.g., Bluck, 2003). The main question of this paper: “But what the hell is it for?” may seem somewhat counter-intuitive in relation to intrusive trauma memories. Naturally, we do not want trauma survivors to suffer from distressing and impairing intrusive memories of their experience. However, we would like to argue that, at least initially, intrusive trauma memory may serve important functions related to survival of the physical and psychological self. Two of the broad categories of autobiographical memory (AM) functions proposed by Bluck (2003) are especially important in the discussion of intrusive trauma memories: the self function and the directive function. The first includes continuity of the self as the same person throughout time and a sense of identity (Barclay, 1996). This continuity relies on knowledge of the self in the past and as projected in the future. Directive functions of AM guide our behaviour through problem solving, predicting future events and interpreting the past (Bluck, 2003).

Trauma memories as originating events

Before we turn to intrusive trauma memories specifically, we first discuss a potential function of trauma memory in general. Intrusive trauma memory may be best viewed as a part of a rich array of post-traumatic reactions that together can have great impact on people's lives. Often, trauma survivors report feeling like a different person after the traumatic event. This personal change relates to what Pillemer (1988) called 'originating events' in his categorization of the types of ways that memories can serve directive functions. The originating event is (often retrospectively) perceived as a cause for life changes and has a motivational (i.e., directive) function (Pillemer, 1988). Bluck, Dirk, Mackay, and Hux (2008) reported that death-related events (although not necessarily traumatic) are often seen as originating events. While negative effects of trauma are obvious, trauma victims have also reported positive outcomes. 'Post-traumatic growth' describes positive outcomes from the struggle with trauma that surpass the pre-trauma level (Zoellner & Maercker, 2006). Trauma victims may report feeling mentally stronger, having a higher appreciation for life, more intimate relationships and new life priorities and values (Tedeschi, Park, & Calhoun, 1998). For example, in a study of burn victims it was found that some participants experienced a renewed self-esteem by overcoming the trauma and having to focus on inner qualities instead of appearance (Andreasen & Norris, 1972). Trauma memory may serve as a reminder of an originating event when new values, life priorities, or personal growth are established.

Unfortunately, a traumatic event can also function as an originating event in a negative way. For example, a woman who was raped by an acquaintance decided not to pursue a career in clinical psychology because she thought that the incident was proof that her judgement of character was too poor (Ehlers & Clark, 2000). Trauma survivors with PTSD may report the feeling of having changed for the worse, feeling alienated from others (Ehlers, Maercker, & Boos, 2000) and experience a sense of foreshortened future (APA, 2000). In line with this, Rubin et al. (2008) found a positive correlation between PTSD symptoms and a measure of the impact of an event on life values and identity.

By discussing the functional value that traumatic events may have we have set the scene to further explore potential functions of *intrusive* trauma memory as a part of a rich array of post-traumatic reactions, experiences and behaviours.

Emotional processing

Brewin, Dalgleish and Joseph (1996) have suggested that intrusive trauma memories may serve a self- and directive function by supplying the trauma survivors with detailed sensory and physiological information about the event. Intrusive trauma memories that are activated can become the focus of conscious attention, during which the meaning of the event can be contemplated and cause and effect relations may be defined (directive function). This is central to emotional processing of the traumatic event that is targeted at restoring core beliefs about safety and control in relation to the self, others and the world (self function). From a neuropsychological perspective, Brewin (2001) has suggested that consciously processed trauma memory (i.e., VAM system) is based on hippocampal activity whereas intrusive trauma memories are related to amygdale processing. The function of intrusive trauma memory may be to transfer detailed sensory trauma information to the 'hippocampally-based VAM system' (Brewin, 2001; p.381), for without flashbacks this information would remain dormant in memory. In sum, intrusive trauma memories provide a source of trauma-related information that is needed for the emotional processing of the traumatic event.

Warning signal hypothesis

One step further, intrusive trauma memory may serve another directive function (Bluck, 2003) by helping to prevent future harm. This 'warning signal hypothesis' (Ehlers, Hackmann, Steil, Clohessy, Wenninger, & Winter, 2002) was formulated based on observations that intrusive trauma memories are often of moments just before the traumatic event. For example, a car accident survivor reported a recurrent intrusive memory of headlights coming towards her, just before the collision (Ehlers et al., 2002). Sometimes intrusive memories are of moments when the meaning of the traumatic event becomes clear. Another road traffic accident survivor reported an intrusive memory of her mother's worried face in the hospital that made her realize that she could have been killed in the crash (Ehlers et al., 2002). Intrusive trauma memories thus provide information of impending danger or threat.

The examples of intrusive trauma memories described above reflect moments of the highest emotional impact that are known as "hotspots" (Ehlers & Clark, 2000; Grey & Holmes, 2008; Grey, Holmes, & Brewin, 2001; Holmes et al., 2005). Interestingly, not all moments of a traumatic event become intrusive. For example, an assault could last an hour, but just two moments may intrude as flashbacks. These hotspots (i.e., moments of the highest emotional impact) give us a clue as to which parts of the trauma become intrusive and which do not, while an analysis of their content helps indicate why. In a study by Holmes et al. (2005), PTSD patients were asked to report the hotspot moments and their intrusive memories of the traumatic event. The hotspot moments were matched with the intrusive trauma memories for every participant. The results showed that 77.6% of the intrusive trauma memories matched the reported hotspots. In a recent replication this match was 83% (Grey & Holmes, 2008). In line with the warning signal hypothesis (Ehlers et al., 2002), the cognitive themes of hotspots reflect physical threat and psychological threat to the self (Holmes et al., 2005; Grey & Holmes, 2008). In other words, intrusive trauma memories often reflect the moments at which one's survival or psychological integrity is questioned.

Although the warning signal function of intrusive trauma memory can clearly be adaptive, in actual PTSD warning signals may generalize to cues that are actually safe. For example, a functional warning cue would be the sight of blood, which indicates a potential threat. But consider a trauma survivor whose warning cues generalize to any red object. The sight of red clothing might then elicit unwanted intrusive memories and a feeling of current threat (Ehlers & Clark, 2000). The feeling of current threat from 'false' (i.e., overgeneralized) warning signals along with an interpretation of that feeling as actual danger enhances the generalization of threat cues and activation of intrusive trauma memories in a vicious cycle (Ehlers et al., 2002).

Protection of self-coherence

Conway, Meares and Standart (2004) have suggested that intrusive trauma memories may play a role in the protection of self-coherence. This argumentation is based on the SMS model of autobiographical memory (Conway & Pleydell-Pearce, 2000; Conway, Singer, et al., 2004). This model states that traumatic information directly threatens self-related goals and the coherence of the self. Therefore, this information will not be easily integrated within the autobiographical knowledge base and the conceptual self. The traumatic information remains an experience-near sensory-detailed record in the episodic memory system and is activated automatically by cues that share sensory features with the memory record. The integration of trauma information into the long-term self (i.e., autobiographical knowledge base and conceptual self) requires dramatic changes in goal structures. Because these changes come at high cognitive and emotional costs integration is avoided in order to protect the current self-coherence (Conway, Singer, et al., 2004; Greenwald, 1980). Intrusive trauma memories reflect the goal structure that the self is trying to protect and thus aid in "holding on" to current beliefs. An example provided by Conway, Meares, et al. (2004) is of the intrusive trauma memory experienced by a professional driver after a car accident in which he was a passenger. The intrusive trauma memory was associated with the victim's belief that he had the time to react and prevent the crash. However, factually, there had been no opportunity for him to do anything. During treatment, the intrusive trauma memory appeared to function as a protection of the belief that he was in control of events. Accepting that he had actually been powerless defied his need for control and would require a drastic change in his goal structure and self (especially as a professional driver). From this viewpoint, the intrusive trauma image reflected the need to preserve a sense of personal control, which is adaptive.

Conway, Meares, et al. (2004) report other examples in which the meaning of the intrusive trauma memory was in line with the current goal system. On a critical note, the authors state that distortions are not always present in intrusive trauma memories. In general, intrusive trauma memories may help to delay the radical change in the long-term self that is needed in order to integrate the traumatic information. They may serve a signal-function that indicates that something is wrong in the interaction between experience and goal structure. However, research is needed to support this suggestion of function.

Intrusive images and memories across psychological disorders

Recent research and practice in clinical psychology highlights that intrusive images also present a significant phenomenon in several other psychological disorders other than PTSD (see Hackmann and Holmes, 2004, for an overview). For example, highly emotional involuntary images *linked to trauma* can occur across the anxiety disorders such as social phobia and obsessive-compulsive disorder (Hirsch & Holmes, 2007). Strikingly, it appears that patients with bipolar disorder may have as frequent trauma flashbacks as patients with PTSD (Holmes, Geddes, Colom, & Goodwin, 2008; Tzemou & Birchwood, 2007). In the area of psychosis, the impact of trauma memories (e.g., to prior hospitalizations) has also been highlighted (Morrison, 2004). Conway et al. (2004) argue that intrusive mental imagery *in general* is strongly related to personal goals in the working self. Thus, intrusive images and memories in different psychological disorders may share similar functions. Mental imagery may bring autobiographical knowledge to life to facilitate or prepare for an action response (Holmes et al., 2008). We therefore suggest that our argumentation so far has wider applicability beyond PTSD to other clinical areas where it is now realized that sudden intrusive sensory memories pose a problem. It is important, both theoretically and practically, to continue the study of intrusive imagery as a phenomenon both regardless and with special regard to different psychological disorders. The functional approach provides a useful lens for doing so.

Summary and implications

Following a long tradition in clinical psychology, we have adopted a continuum view of intrusive trauma memory in which intrusions can occur from mildly distressing everyday images to full-blown flashbacks in PTSD. This is strongly related to the continuum perspective proposed by Holmes (2004) in which intrusive images are found in experimental settings, in response to media broadcasting, witnessing a traumatic event as well as in trauma survivors. While intrusive trauma memories are very distressing and knowledge about how to reduce their impact are highly valuable, it should also be considered what functions might be lost when we succeed in reducing them. In relation to the phenomenon of intrusive trauma memory we therefore explored the central question “But what the hell is it for?”. While in full-blown PTSD intrusive trauma memories reflect a maladaptive response contributing to the disorder, the basic underlying mechanisms (e.g., high sensory imagery, automatic retrieval in response to cues) may reflect the way in which our memories are adaptively set up to help us learn from and navigate through our intense emotional experiences.

Intrusive trauma memory is one part of a rich array of possible post traumatic reactions. A traumatic event as a whole may function as an originating event (Pillemer, 1988). Whereas positive changes may arise in post-traumatic growth (Zoellner & Maercker, 2006), on the pathological side of the continuum trauma survivors can also feel they have changed for the worse, or have a sense of foreshortened future (Ehlers et al., 2000). Within this larger mechanism, intrusive trauma memory has its own specific functions.

The first function of intrusive trauma memory that we identified was aimed at the emotional processing of a traumatic event. Intrusive trauma memories may provide an opportunity to highlight important trauma information (specifically sensory and physiological details) that would not have been available through deliberate recall. By directing conscious attention towards an active intrusive trauma memory, a rich record of the trauma can be constructed.

The second function that we discussed is a warning signal function. Intrusive trauma memories may provide information about impending danger and may prepare the person for action by an associated feeling of current threat (Ehlers et al., 2002). Basically, this is potentially a helpful and adaptive function. But when danger cues generalize to cues that are actually safe, intrusion frequency is elevated and can become impairing. In order to recover, the person needs to re-evaluate the ‘true’ informational value of each cue. One component of treatment is to distinguish between danger signs in the past and safety signs in the present (Ehlers & Clark, 2000).

The third possible function of intrusive trauma memory was suggested by Conway, Singer, et al. (2004). Intrusive trauma memories and their distortions may function to protect the status quo of the self’s goal structure and thus self-coherence. Intrusive trauma memories reflect the self’s active goals at time of the trauma that in turn reflect firmly held beliefs about the self that are challenged by the traumatic event. Changes in the self’s goal structure may be avoided to maintain self-coherence by intrusive trauma images (Conway, Singer, et al., 2004). Although intrusive trauma memories are often distressing they may be more pleasant than giving up self-coherence, and in that sense can be seen as adaptive. As does the warning signal hypothesis, the function of self-coherence suggests that there may be valuable information in research of the content of intrusive trauma memories as, for example, the reported hotspot studies (e.g., Grey & Holmes, 2008).

While some theoretical models have suggested a functionality of intrusions (e.g., Brewin et al., 1996; Ehlers & Clark, 2000; Conway & Pleydell-Pearce, 2000), it needs to be highlighted that little research has tested these ideas directly. At the time of Baddeley's question "But what the hell is it for?" (1988) there was a growing interest in applying specific experimental paradigms to the study of different memory phenomena. However, the everyday relevance of such research was not always taken into account. Baddeley (1988) argued for contemplation on possible functions in order to identify research topics that really matter to the lives of human beings. While the link between experimental study of memory phenomena and its social relevance is not always clear, where clinical disorders are concerned there is a clear imperative to better understand the underlying processes. As noted, intrusive trauma memories can be highly distressing and impairing. Therefore, research on the aetiology and function of intrusive trauma memories is clearly important for the development of more effective treatments. The studies on intrusion development that we reviewed in the introduction are clearly socially relevant, and even suggest new experimentally-driven ways of working with intrusive memories that appear very unlike traditional psychological therapies (Holmes et al., 2009; Lang, Moulds, & Holmes, 2009; Lilley et al., in press; Mackintosh, Woud, Postma, Dalgleish, & Holmes, submitted). In light of the clinically relevant phenomenon of intrusive trauma memory, we need to study the function in order to achieve a nuanced view on the possibilities and consequences of changing intrusion development in psychological treatment and research.

Chapter 11

Summary and general discussion

Theoretical evaluation of research findings

This dissertation investigated the cognitive processes underlying intrusion development using an analogue trauma paradigm. Two influential information processing theories of PTSD (Brewin, Dalgleish, & Joseph, 1996; Ehlers & Clark, 2000) and a pragmatic model based on the converging implications of these theories (Holmes & Bourne, 2008) formed the theoretical background of the dissertation. In Chapter 2, these models were outlined and available studies of information processing and intrusion development using the trauma film paradigm were reviewed.

Intrusion development according to information processing models of PTSD

Chapter 3 aimed to confirm the role of peri-traumatic visuospatial processing in intrusion development by ruling out the alternative hypothesis that movement per se is related to intrusion development. Indeed, performing a configurational movement task while viewing an aversive film did not modulate intrusion frequency in the following week compared to performing no concurrent task. In contrast, performing a visuospatial movement task (complex pattern tapping) decreased the frequency of intrusive images, and, interestingly, also deliberate recall of the film. The results thus provide support for the role of visuospatial processing in intrusion development. However, the results conflict with the dual representation theory (DRT; Brewin, et al., 1996) in that the visuospatial task decreased deliberate recall as well as intrusion frequency. Although the findings support an image-based memory system underlying intrusive images (the SAM system), the decrease in intrusive images is not compatible with a decrease in deliberate recall (the VAM system) as proposed in the DRT. The findings of Chapter 3 are more in line with the notion of data-driven processing in the cognitive model of PTSD (Ehlers & Clark, 2000) and the role of visuospatial processing in intrusion development as suggested by the pragmatic model (Holmes & Bourne, 2008).

Chapter 4 explored the role of peri-traumatic verbal processing in intrusion development. Interfering with verbal processing during the encoding of an aversive film reduced both intrusion frequency and deliberate recall of the film scenes after one week. Our manipulation to enhance peri-traumatic verbal processing was unsuccessful, as it appeared to be a very difficult task for participants. The finding that a verbal concurrent task decreased both intrusion frequency as well as deliberate recall of the film is clearly in contrast with the notion that peri-traumatic verbal processing, to the extent that it underlies conceptual processing, 'protects' against intrusion development. Thus, our findings do not match with the role of conscious conceptual peri-traumatic processing driven by verbal resources as suggested by the dual representation theory (Brewin et al., 1996), the cognitive model of PTSD (Ehlers & Clark, 2000), and the pragmatic model of intrusion development (Holmes & Bourne, 2008). Our findings contradict two earlier studies (Holmes, Brewin, & Hennessy, 2004, Experiment 3; Bourne, Frasquilho, Roth, & Holmes, submitted) that found an increase in intrusion frequency from peri-traumatic verbal interference. Rather, our findings seem to suggest that cognitive load (i.e., a reduction in central executive functioning) reduced encoding of the film resulting in fewer trauma information in episodic memory. Such an interpretation is more in line with general theories of attention and memory (Baddeley & Hitch, 1994; Cowan, 1995; Conway, 1996). Clearly, more research is needed to clarify these differences.

Chapter 5 tested the hypothesis that rehearsing analogue trauma information reduces intrusion frequency by enhancing memory processing *after* viewing an aversive film. Participants indeed reported fewer intrusions and enhanced deliberate recall for the film part for which they had received a chronological verbal recognition memory test immediately post-film, confirming the hypothesis. Chapter 5 thus provides support for a 'protective' role of *post*-traumatic verbal processing. This is in line with all three information processing models of PTSD (Brewin et al., 1996; Ehlers & Clark, 2000; Holmes & Bourne, 2008) stating that trauma information should be processed conceptually in order to integrate the information into existing knowledge structures, which would decrease the proneness for automatic activation.

Mental imagery and intrusion development

In Chapter 6, it was explored whether intrusive visual images could emerge from listening to a verbal description of a traumatic event and whether these images could be modulated through interference with encoding. Confirmatively, participants reported intrusive visual images of the narrative in a one-week diary. Furthermore, performing a visuospatial task or a verbal task while listening to the description reduced intrusion frequency compared to no concurrent task after one week. This finding overlaps with Chapter 3 and 4 in which both a visuospatial and a verbal task decreased intrusion frequency of a trauma film, suggesting a role of central executive functioning in the encoding of intrusive images that is not modality-specific.

Chapter 7 aimed to further explore the working mechanisms underlying intrusive visual images from a verbal description of a traumatic event. Preferred visual (but not verbal) processing style was found to be positively related to intrusion frequency when participants imagined a traumatic verbal report. This is not surprising, considering the fact that intrusive images are often visual in nature (Speckens, Ehlers, Hackmann, Ruths, & Clark, 2007). Additionally, participants in the imagery condition reported more avoidance of the traumatic story and increased negative cognitions about the world. Speculatively, self-relevance may play an important role in intrusion development. This interpretation is supported by the finding that intrusive images include only highly meaningful moments of the traumatic event (Ehlers, Hackmann, Steil, Clohessy, Wenninger, & Winter, 2002). A theoretical background for the role of self-relevance is provided by the Self-Memory System (SMS; Conway & Pleydell-Pearce, 2000). In the SMS model it is hypothesized that intrusive images may reflect active goals of the self that are threatened by the trauma (see also Chapter 10). This potentially serves the function of preserving self-coherence by rehearsing and thereby confirming pre-trauma beliefs that are not in line with the reality of the trauma (see Chapter 11).

By focusing on intrusive visual images from a description rather than from direct visual input of an analogue trauma, Chapter 6 and 7 clearly extend the information processing models of PTSD. These models are based on an assumption of direct perceptual input, but apparently, mental imagery can be used to create visual images in the mind that appear as intrusive images later on. Direct input from the visual system is clearly not a requirement for intrusion development. This finding points out a limitation of information processing models of PTSD as these do not explain intrusive images from mental imagery.

Other cognitive processes in intrusive images: Thought suppression and attentional bias

Whereas Chapter 3 to 7 mainly focused on the aetiology of intrusive images, Chapter 8 and 9 are more relevant for their maintenance. In Chapter 8 it was investigated whether an intrusive image from an aversive film would be more difficult to suppress than a non-intrusive image. The goal of this study was to distinguish between an 'intrusion' as a result of encoding processes (i.e., intrusive images of an event) and an 'intrusion' as a direct result of thought suppression efforts. The findings suggested that thought suppression success was dependent on individual ability rather than on the intrusive character of the to-be suppressed target. Thought suppression success was highly and positively related to intrusive images of the aversive film that participants reported in a one-week diary. Furthermore, prolonged activation of the intrusive image after suppression efforts was also positively correlated with the intrusion diary, indicating an effect specific for intrusive (versus non-intrusive) images. The findings support the role of thought suppression in the maintenance of intrusive images. Both the individual ability to suppress targets as well as the intrusive character of the image appeared to be important for the occurrence of intrusive images in the diary. The role of thought suppression in the maintenance of intrusive images has been suggested by both the dual representation theory (Brewin et al., 1996) and the cognitive model of PTSD (Ehlers & Clark, 2000).

Chapter 9 explored whether an attentional bias exists for threat stimuli after exposure to threat pictures. Participants who had previously viewed negative pictures (Trauma group) showed an attentional interference bias of a neutral target on encounter with a threat stimulus. This bias generalized to threat stimuli that shared no perceptual similarities with the initial analogue traumatic event. Threat pictures that were viewed prior to the attentional bias task additionally benefited from enhanced processing. These effects were not found for participants who had previously viewed neutral pictures only. The effects were not due to mere familiarity and only occurred after exposure to threat stimuli (i.e., viewing the negative pictures). Finally, attentional control (attentional shifting specifically) was positively related to enhanced processing of both familiar and new threat stimuli in the Trauma group. The findings presented in Chapter 9 are in line with the cognitive model of PTSD (Ehlers & Clark, 2000) where it is suggested that the feeling of 'current threat' in PTSD is a result of the generalization of a fear reaction and enhanced priming due to stimuli that are associated with the trauma but are objectively non-threatening.

Potential functions of intrusive trauma memory

The research findings summarised above provide more insight in the development of intrusive trauma memory, and add to our knowledge of how to decrease these unwanted occurrences. However, it is also possible that intrusive trauma memory serves potentially important functions. In the theoretical Chapter 10, potential functions of intrusive trauma memory described in the literature were reviewed. Three potential functions were found. First, information stored in intrusive images can provide significant information necessary for the emotional processing of a traumatic event. Second, the occurrence of an intrusive image may serve as a warning signal. This proposition was based on the observation that intrusive images are often of the moment right before the traumatic event, when it became clear that the situation took a turn for the worse. Third, intrusive images may serve to protect the coherency of the self. Traumatic information conflicts with a person's valued goals. In order to integrate the traumatic information in autobiographical memory, personal goals may have to be adjusted (sometimes for the worse) and this can be a painful emotional process. The maintenance of intrusive images may aid self-coherence by prolonging these sometimes radical changes.

A psychological model of intrusion development: Mii

As has been discussed above, the current information processing models of PTSD (e.g., Ehlers & Clark, 2000; Brewin et al., 1996; Holmes & Bourne, 2008) cannot fully account for all the research findings presented in Chapters 3 to 9. First, no support was found for the importance of modality-specific peri-traumatic processing or for two separate memory systems (see Chapters 3, 4, and 6). Second, the information processing models of PTSD cannot account for intrusive images without direct input from the visual system, i.e., through mental imagery. Third, the present models do not explain why we have the specific intrusions that we have. Overall, the findings presented in this dissertation are more in line with non-clinical models of autobiographical memory, such as the Self-Memory System (e.g., Conway & Pleydell-Pearce, 2000) that consider intrusive memories to be experience-near episodic memories that have not been integrated into conceptual knowledge structures. The SMS model also elaborates on the meaning of intrusive images in an enticing way. However, such general models of autobiographical memory lack the inclusion of specific cognitive processes that are clinically relevant, such as avoidance. In sum, the findings presented in this dissertation stretch the scope of existing models of intrusion development and require revision of our view on intrusions. To account for these issues a new psychological model of intrusion development is presented here (see Figure 1). The model also encourages trans-diagnostic research as it is a model of intrusion development outside of the context of a specific psychological disorder.

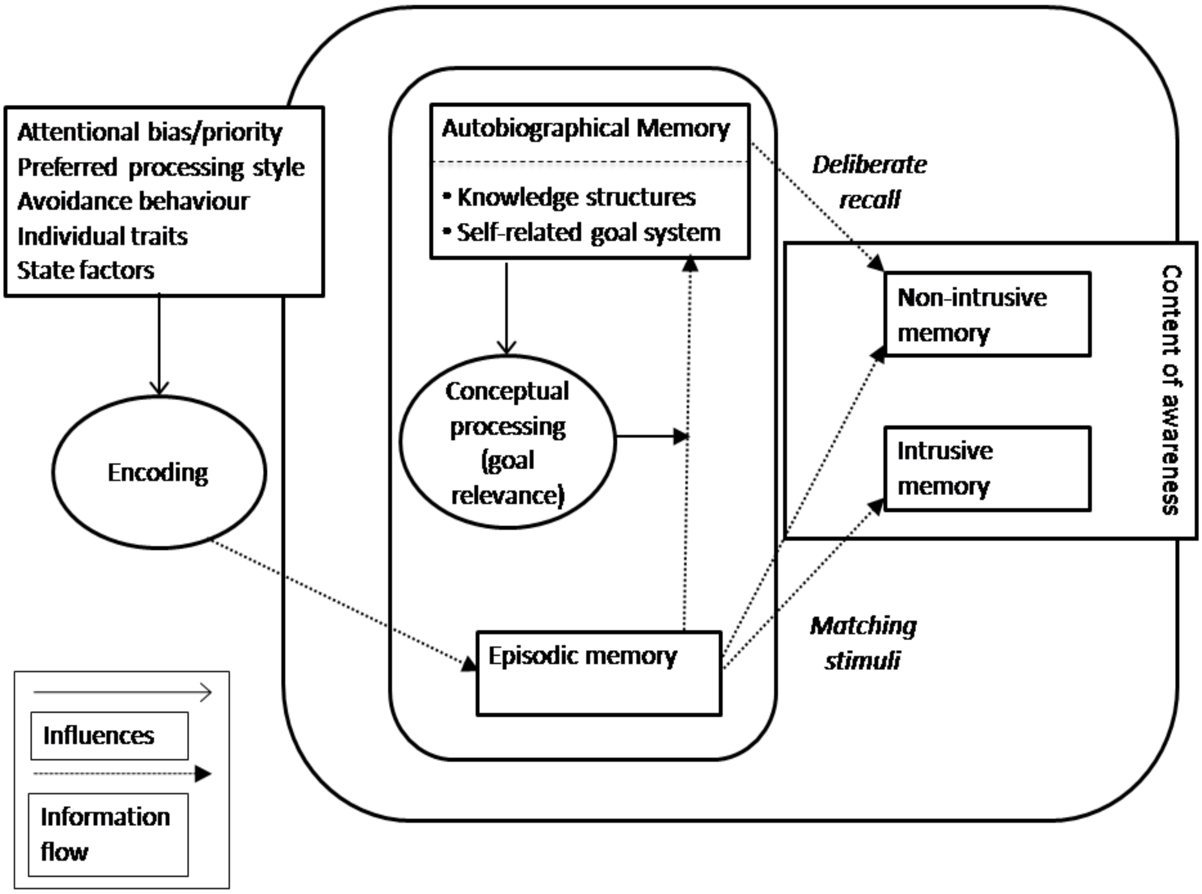

Figure 1. The psychological model of intrusive images (Mii).

The psychological model of intrusive images (Mii) is mainly based on the dual representation theory (Brewin, Dalgleish, & Joseph, 1996), the cognitive model of PTSD (Ehlers & Clark, 2000), and the Self-Memory-System model of autobiographical memory (Conway & Pleydell-Pearce, 2000). During a traumatic event, several trait and state characteristics of the individual determine what information is attended to and encoded.

Examples are attentional biases for particular information, preferred processing style (e.g., verbal or visual), avoidance behaviour (e.g., selective attention), as presented in Chapter 7 and 9. Note that the encoding process does not necessarily need to involve primary sensory input (i.e., direct experience) but can also involve secondary experiences brought to life with mental imagery. The trauma information is initially stored as an episodic memory. Characteristically, episodic memory is highly detailed and becomes frequently active in consciousness so that the information can be processed conceptually into a more abstract form, such as schemas (Conway & Pleydell-Pearce, 2000). During this time, matching stimuli can automatically trigger the trauma memory representation and an intrusive memory is experienced in consciousness (Brewin et al., 1996; Ehlers & Clark, 2000).

However, in contrast to the dual representation theory of PSTD (Brewin et al., 1996; Brewin, 2001), the Mii suggests that the trauma information can also be accessed deliberately. As mentioned in Chapter 2, it depends on the retrieval route, rather than on encoding differences, whether an intrusive or non-intrusive 'regular' memory experience occurs (Rubin, Boals, & Berntsen, 2008). Normally, the episodic memory is conceptually processed and integrated into long-term memory. That is, the information is organized, for example, in a chronological order as presented in Chapter 5. Furthermore, information that is important for and complies with self-related goals in the autobiographical memory system (Conway & Pleydell-Pearce, 2000) is integrated within the knowledge structures in long-term memory and the autobiographical knowledge base. There may be at least two processes that can undermine the adequate processing of the trauma information and thus underlie the maintenance of intrusive re-experiencing. First, conceptual processing may be hampered by cognitive avoidance behaviour such as thought suppression. Thought suppression[2] not only prevents conceptual processing of the information in the long-term but also leads to an immediate increase in intrusive memories by ironic processes, as described in Chapter 8. Second, trauma information that conflicts with or threatens the self (e.g., I have control over events) is not easily brought in line with the existing autobiographical knowledge base.

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[2] As suppression efforts may have differential short- and long-term consequences it is not presented in the Mii model for lay-out purposes. However, short-term thought suppression effects would be noticed in the contents of awareness, whereas long-term effects would play a role in the conceptual processing of episodic information.

Therefore, the information may remain in its highly detailed form because it is not fully processed conceptually. That is, the threat to the goal-system of the self needs to be reduced first in order for the information to be integrated in long-term memory (see Chapter 10 on the potential function of intrusive trauma memory to preserve self-coherency), for example, through cognitive restructuring. If successful, the trauma information is integrated within the autobiographical knowledge structures. At this stage, the trauma information, in turn, influences the self and self-related goal structure that derives from the autobiographical knowledge structures (Conway & Pleydell-Pearce, 2000). The self-related goal system, in turn, influences the interaction between the person and the environment through individual differences as mentioned earlier.

The Mii describes the development and maintenance of intrusion development for, for example, PTSD. It also allows for intrusive experiences in the aftermath of trauma that will not persist and are part of a normal post-traumatic reaction. The Mii is not limited to PTSD and can also account for intrusions in other clinical disorders as well as non-clinical intrusive experiences. A main assumption of the Mii is that mechanisms underlying intrusive images are qualitatively similar across disorders and in everyday life occurrences. Differentiating characteristics such as persistence and associated distress are thought to arise from differences in variables such as the emotional impact of the event, coping behaviour (e.g., avoidance) and discrepancy between the information and self-relevant goals.

The Mii does not include specifications of peri-traumatic processing. There are three reasons for this. First, the Mii assumes that all information is initially encoded in episodic memory, including information from all available modalities. It is mostly after the traumatic event that the information is elaborated on conceptually. Thus, there is no need for a distinction between different types of processing. Rather, the self-relevance of the information determines whether the information is processed conceptually post-trauma or whether it still remains active in its original form until some goal-discrepancy is resolved. Consequently, an intrusive image will be experienced when the trauma information is stored as a highly detailed episodic memory and a matching stimulus is encountered. In turn, deliberate recall is achieved by verbal search. This is easier when the trauma information is integrated within long-term memory as this facilitates top-down search (Conway & Pleydell-Pearce, 2000). Second, the findings presented in Chapter 6 and 7, show that intrusive images can also develop from mental imagery in the absence of direct visual input. If, then, direct visual input is not a necessary ingredient for intrusion development, it does not have a central role in a model of intrusion development. Third, the combined findings of Chapter 3, 4, and 6 suggest that it may be more general central executive processes that are involved in the encoding of information during a(n analogue) traumatic event and not modality-specific resources. However, distinguishing different forms of peri-traumatic processing may well be important (though perhaps not sufficient) in actual traumatic events. The use of a mild stressor (e.g., a trauma film) as an analogue trauma limits further conclusions on this issue.

Limitations and future research

The Mii focuses on intrusion development specifically rather than on all diagnostic criteria for PTSD and therefore does not provide a full explanation of all PTSD-related symptoms. Conversely, this has the advantage that the Mii can also be tested across psychological disorders. Recently, there has been more interest in studying intrusive memories in, for example, OCD, social phobia, depression, and bipolar disorder (e.g., Brewin, Gregory, Lipton, & Burgess, 2010). The Mii provides a testable view on intrusion development across disorders and daily life.

The Mii is the result of embedding the findings presented in this dissertation within existing cognitive frameworks of PTSD (i.e., Brewin et al., 1996; Ehlers & Clark, 2000; Conway & Pleydell-Pearce, 2000). The Mii is therefore not exhaustive but rather leaves room for extension. At the very least, the results presented in this dissertation need to be replicated and further explored. For example, in what other ways can post-trauma conceptual processing be aided and are there different kinds of conceptual evaluations that can be distinguished in this process? Importantly, the main assumption in the Mii about the relationship between intrusion development and self-relevance has hardly been studied experimentally. An interesting field of research that may become important in the future is the content of intrusive images (in contrast to quantitative frequency). The present dissertation has added to the knowledge of intrusion development, but why do people experience the specific intrusions that they do?

Conclusions

The main contribution of this dissertation for the field of intrusive memory has been the empirical investigation of prominent information processing models of PTSD on this issue (e.g., Ehlers & Clark, 2000; Brewin et al., 1996). The studies presented above have provided limited support, but also disconfirmation and extension of these models. Most importantly, the main findings did not provide convincing support for a modality-specific encoding of analogue trauma information nor for a separation of encoding of intrusive versus deliberately recalled memories. Rather, the findings are more in line with non-PTSD models of autobiographical memory, such as the Self-Memory System (Conway & Pleydell-Pearce, 2000). Central executive function, regardless of modality, appeared to underlie the encoding of the analogue traumatic material, thereby modulating both intrusive and deliberately recalled information. However, models of autobiographical memory lack inclusion of other clinically relevant processes such as avoidance. Based on the empirical data that resulted from the efforts made in this dissertation, a new psychological model of intrusive images, the Mii, was presented. The Mii can generate hypotheses and drive empirical studies of psychological mechanisms underlying intrusion development in a trans-diagnostic fashion. Especially the notion of conceptual processing, and meaningfulness, of traumatic information for the individual will be a fruitful future enterprise.

Chapter 12:

Samenvatting

Theoretische evaluatie van de onderzoeksbevindingen

Dit proefschrift verkende de cognitieve processen onderliggend aan de ontwikkeling van intrusies gebruik makend van het trauma film paradigma. Twee invloedrijke PTSS theorieën (Brewin, Dalgleish, & Joseph, 1996; Ehlers & Clark, 2000) en een pragmatisch model gebaseerd op de overlappende implicaties van deze theorieën (Holmes & Bourne, 2008) vormden de theoretische achtergrond van het proefschrift. In Hoofdstuk 2 werden deze modellen uiteengezet en werd een overzicht gegeven van de bestaande studies naar informatieverwerking en de ontwikkeling van intrusies die gebruik maakten van het trauma film paradigma.

De ontwikkeling van intrusies volgens informatieverwerkingsmodellen van PTSS

Het doel van Hoofdstuk 3 was om de rol van peri-traumatische visuospatiële verwerking in de ontwikkeling van intrusies te bevestigen door het uitsluitend van de alternatieve hypothese dat beweging per se is gerelateerd aan de ontwikkeling van intrusies. Inderdaad bleek dat het uitvoeren van een configurationele bewegingstaak tijdens het kijken naar een aversieve film de frequentie van intrusies niet moduleerde in de volgende week vergeleken met het niet uitvoeren van een gelijktijdige taak. Het uitvoeren van een visuospatiële bewegingstaak (complex patroon tapping) verminderde echter de frequentie van intrusieve beelden en, interessant genoeg, ook het bewust gestuurde herinneren van de film. De resultaten steunen dus de rol van visuospatiële verwerking in de ontwikkeling van intrusies. Echter, de resultaten zijn in strijd met de dual representation theory (DRT; Brewin et al., 1996) in dat de visuospatiële taak zowel het bewust gestuurde herinneren als de intrusie frequentie verminderde. Hoewel de bevindingen een beeldgebaseerd geheugensysteem onderliggend aan intrusieve beelden (het SAM systeem) ondersteunen is de vermindering van intrusieve beelden niet in overeenstemming met een vermindering in het bewust gestuurde herinneren (het VAM systeem) zoals voorgesteld in de DRT. De bevindingen van Hoofdstuk 3 komen meer overeen met de notie van datagedreven verwerking in het cognitieve model van PTSS (Ehlers & Clark, 2000) en de rol van visuospatiële verwerking in de ontwikkeling van intrusies zoals voorgesteld door het pragmatische model (Holmes & Bourne, 2008).

Hoofdstuk 4 onderzocht de rol van peri-traumatische verbale verwerking in de ontwikkeling van intrusies. Interferentie met de verbale verwerking tijdens de codering van een aversieve film verminderde zowel de frequentie van intrusies als het bewust gestuurde herinneren van de film scènes na een week. Onze manipulatie om peri-traumatische verbale verwerking te verbeteren was niet succesvol, want het bleek een zeer moeilijke taak voor de proefpersonen. De bevinding dat een verbale concurrerende taak zowel intrusie frequentie als het bewust gestuurde herinneren van de film verminderde is duidelijk in strijd met de notie dat peri-traumatische verbale verwerking, in zoverre dit onderliggend is aan conceptuele verwerking, tegen de ontwikkeling van intrusies 'beschermt'. Onze bevindingen komen dus niet overeen met de rol van bewuste peri-traumatische verwerking gedreven door verbale capaciteiten zoals voorgesteld door de dual representation theory (Brewin et al., 1996), het cognitieve model van PTSS (Ehlers & Clark, 2000), en het pragmatische model van intrusie ontwikkeling (Holmes & Bourne, 2008). Onze bevindingen zijn in strijd met twee eerdere studies (Holmes, Brewin, & Hennessy, 2004, Experiment 3; Bourne, Frasquilho, Roth, & Holmes, submitted) die een stijging in intrusie frequentie vonden door peri-traumatische verbale interferentie. Onze bevindingen lijken eerder aan te geven dat cognitieve lading (een vermindering in de centraal executieve functie) de codering van de film verminderde wat resulteerde in minder trauma informatie in het episodisch geheugen. Een dergelijke interpretatie komt meer overeen met algemene theorieën van aandacht en geheugen (Baddeley & Hitch, 1994; Cowan, 1995; Conway, 1996). Er is duidelijk meer onderzoek nodig om deze verschillen op te helderen.

Hoofdstuk 5 testte de hypothese dat het herhalen van analoge trauma informatie de frequentie van intrusies vermindert door de verwerking in het geheugen *na* het kijken van een aversieve film te verbeteren. Proefpersonen rapporteerden inderdaad minder intrusies en betere bewust gestuurde herinneringen voor het deel van de film waarvoor zij een chronologische verbale geheugentest (herkenning) hadden gekregen meteen na de film, wat de hypothese bevestigde. Hoofdstuk 5 ondersteunt dus de 'beschermende' rol van *post*-traumatische verbale verwerking. Dit is in overeenstemming met alle drie informatieverwerkingsmodellen van PTSS (Brewin et al., 1996; Ehlers & Clark, 2000; Holmes & Bourne, 2008) die stellen dat trauma informatie conceptueel verwerkt zou moeten worden om te kunnen integreren met de informatie in bestaande kennisstructuren, wat de gevoeligheid voor automatische activering zou verminderen.

Mentale verbeelding en de ontwikkeling van intrusies

In Hoofdstuk 6 werd onderzocht of intrusieve visuele beelden kunnen ontstaan door het luisteren naar een verbale beschrijving van een traumatische gebeurtenis en of deze beelden gemoduleerd kunnen worden door interferentie met de codering. Proefpersonen rapporteerden inderdaad intrusieve visuele beelden van het verhaal in een weekdagboek. Verder verminderde het uitvoeren van een visuospatiële taak of een verbale taak tijdens het luisteren naar de beschrijving de ontwikkeling van intrusies na een week vergeleken met geen concurrerende taak deze bevinding overlapt met Hoofdstuk 3 en 4 waarin zowel een visuospatiële als een verbale taak de intrusie frequentie van een trauma film verminderde, wat een rol van de centraal executieve functie suggereert in de codering van intrusieve beelden die niet modaliteitspecifiek is.

Hoofdstuk 7 had als doel de werkzame mechanismen onderliggend aan intrusieve visuele beelden van een verbale beschrijving van een traumatische gebeurtenis te onderzoeken. Een voorkeur voor een visuele (maar niet verbale) verwerkingsstijl was positief gerelateerd aan de frequentie van intrusies wanneer de proefpersonen zich het traumatische verbale verhaal verbeeldden. Dit is niet verrassend, aangezien intrusieve beelden vaak visueel van aard zijn (Speckens, Ehlers, Hackmann, Ruths, & Clark, 2007). Verder rapporteerden proefpersonen in de verbeeldingsconditie meer vermijding van het traumatische verhaal en meer negatieve cognities over de wereld. Een speculatie is dat zelfrelevantie een belangrijk rol zou kunnen spelen in de ontwikkeling van intrusies. Deze interpretatie wordt ondersteund door de bevinding dat intrusieve beelden alleen van zeer betekenisvolle momenten van de traumatische gebeurtenis zijn (Ehlers, Hackmann, Steil, Clohessy, Wenninger, & Winter, 2002). In het SMS model wordt de hypothese gesteld dat intrusieve beelden de actieve doelen van het zelf zouden kunnen reflecteren die bedreigd worden door de trauma (zie ook Hoofdstuk 10). Dit kan potentieel de functie van het behoud van zelfcoherentie ondersteunen door het herhalen en daarbij bevestigen van overtuigingen vóór de trauma die niet overeenkomen met de realiteit van de trauma (zie Hoofdstuk 11).

Hoofdstuk 6 en 7 breiden de informatieverwerkingsmodellen van PTSS duidelijk uit door de focus te leggen op intrusieve visuele beelden van een beschrijving en niet op beelden die ontstaan uit directe visuele input van een analoog trauma. Deze modellen zijn gebaseerd op een aanname van directe perceptuele input maar blijkbaar kan mentale verbeelding gebruikt worden om visuele beelden in ons hoofd te creëren die later als intrusieve beelden verschijnen. Directe input van het visuele systeem is dus duidelijk geen vereiste voor de ontwikkeling van intrusies. Deze bevinding duidt op een beperking van de informatieverwerkingsmodellen van PTSS omdat deze intrusieve beelden van mentale verbeelding niet verklaren.

Andere cognitieve processen in intrusieve beelden: Gedachteonderdrukking en aandachtsbias

Waar Hoofdstuk 3 tot en met 7 zich voornamelijk richten op de etiologie van intrusieve beelden zijn Hoofdstuk 8 en 9 relevanter voor hun instandhouding. In Hoofdstuk 8 werd onderzocht of een intrusief beeld van een aversieve film moeilijk te donderdrukken zou zijn dan een niet-intrusief beeld. Het doel van deze studie was om een onderscheid te maken tussen een ‘intrusie’ als resultaat van coderingsprocessen (intrusieve beelden van een gebeurtenis) en een ‘intrusie’ als een direct resultaat van effecten van pogingen tot gedachteonderdrukking. De bevindingen stellen dat het succes van gedachteonderdrukking afhankelijk was van individuele vaardigheid en niet van het intrusieve karakter van het te onderdrukken target. Succes van gedachteonderdrukking was hoog positief gerelateerd aan intrusieve beelden van de aversieve film die proefpersonen rapporteerden in een weekdagboek. Verlengde activering van het intrusieve beeld na de onderdrukkingspoging was tevens positief gecorreleerd met het intrusiedagboek, wat een specifiek effect voor intrusieve (versus niet-intrusieve) beelden aangeeft. De bevindingen ondersteunen de rol van gedachteonderdrukking in de instandhouding van intrusieve beelden. Zowel de individuele vaardigheid om targets te onderdrukken als het intrusieve karakter van het beeld bleken belangrijk te zijn voor het vóórkomen van intrusieve beelden in het dagboek. De rol van gedachteonderdrukking in de instandhouding van intrusieve beelden is oorgesteld door zowel de dual representation theory (Brewin et al., 1996) als het cognitieve model van PTSS (Ehlers & Clark, 2000).

Hoofdstuk 9 verkende of er een aandachtsbias bestaat voor bedreigende stimuli na de blootstelling aan bedreigende plaatjes. Proefpersonen die eerder negatieve plaatjes hadden gezien (Trauma groep) lieten een interferentie aandachtsbias zien van een neutrale target bij het tegenkomen van een bedreigende stimulus. Deze bias generaliseerde naar bedreigende stimuli die geen perceptuele kenmerken deelden met de oorspronkelijke analoge traumatische gebeurtenis. Bedreigende plaatjes die waren bekeken voor de aandachtsbias taak kregen een voorkeur en werden beter verwerkt. Deze effecten werden niet gevonden voor de proefpersonen die eerder alleen neutrale plaatjes hadden bekeken. De effecten konden niet worden toegewezen aan bekendheidseffecten en waren alleen aanwezig na blootstelling aan bedreigende stimuli (het kijken van de negatieve plaatjes). Ten slotte was aandachtscontrole (specifiek het verschuiven van de aandacht) positief gerelateerd aan het beter verwerken van zowel bekende als nieuwe bedreigende stimuli in the Trauma groep. De bevinding uit Hoofdstuk 9 komen overeen met het cognitieve model van PTSS (Ehlers & Clark, 2000) waar gesteld wordt dat het gevoel van ‘huidige bedreiging’ in PTSS een resultaat is van de generalisatie van een vreesreactie en verhoogde perceptuele priming door stimuli die geassocieerd zijn met de trauma maar objectief gezien niet bedreigend zijn.

Mogelijke functies van intrusief trauma geheugen

De onderzoeksbevindingen die hier boven staan opgesomd verschaffen meer inzicht in de ontwikkeling van intrusief trauma geheugen, and dragen bij aan onze kennis hoe deze ongewilde verschijningen te verminderen. Het is echter ook mogelijk dat intrusief trauma geheugen mogelijk belangrijke functies heeft. In het theoretische Hoofdstuk 10 worden mogelijke functies van intrusief trauma geheugen uiteengezet zoals deze in de literatuur vóórkomen. Er werden drie mogelijke functies gevonden. Ten eerste kan de informatie die is opgeslagen in intrusieve beelden significante informatie bevatten die nodig is voor de emotionele verwerking van een traumatische gebeurtenis. Ten tweede zou het verschijnen van een intrusief beeld kunnen dienen als een waarschuwingssignaal. Dit voorstel was gebaseerd op de observatie dat intrusieve beelden vaak van het moment zijn vlak voor de traumatische gebeurtenis, wanneer het duidelijk werd dat de situatie verslechterde. Ten derde zouden intrusieve beelden de zelfcoherentie kunnen beschermen. Traumatische informatie is in conflict met belangrijke waarden van een persoon. Om de traumatische informatie te kunnen integreren in het autobiografisch geheugen moeten persoonlijke doelen wellicht worden aangepast (soms in negatieve zin) en dit kan een pijnlijk emotioneel proces zijn. De instandhouding van intrusieve beelden zou de zelfcoherentie kunnen ondersteunen door deze soms radicale veranderingen te vertragen.

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Curriculum Vitae

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